A 5-YEAR PLAN FOR RESEARCH AND MONITORING OF THE EASTERN NORTH PACIFIC POPULATION OF GRAY WHALES

Prepared by the

Gray Whale Monitoring Task Group
National Marine Fisheries Service, NOAA

for the

Assistant Administrator for Fisheries
U.S. Department of Commerce, NOAA
National Marine Fisheries Service
1335 East West Highway
Silver Spring, MD 20190

October 1993

National Marine Mammal Laboratory
Alaska Fisheries Science Center
National Marine Fisheries Service, NOAA
7600 Sand Point Way, N.E.
Seattle, WA 98115

Preface

The 1988 amendments to the U.S. Endangered Species Act (ESA) specify that monitoring plans be developed and implemented for any vertebrate population that is removed from the list of endangered and threatened wildlife. An initial period of five years post-delisting was specified in the ESA for monitoring and assessment. The intent of Congress in adding this mandate was to apply the "precautionary principle" to provide some assurance that the initial decision was not in error.

The purpose of monitoring populations following delisting is to evaluate the validity of the status determination used in the delisting process and to determine whether the status of the population has deteriorated within a 5-year period subsequent to delisting. If information collected during the initial 5-year monitoring period indicates that the status determination that lead to delisting was in error, or that its status has deteriorated sufficiently to be considered threatened or endangered, the ESA requires the agency with management authority to promote the recovery of this population with increased protection and add (i.e., return or reclassify) the population to the list of endangered and threatened wildlife.

The National Marine Fisheries Service (NMFS) has the responsibility of carrying out a monitoring program for populations of marine mammals under its authority that are removed from the list of endangered and threatened wildlife. Dr. Nancy Foster, Acting Assistant Administrator for Fisheries, detailed a monitoring task group under the direction of the National Marine Mammal Laboratory, Alaska Fisheries Science Center, to develop a monitoring plan for the eastern North Pacific population of gray whale, which is proposed for delisting. The Gray Whale Monitoring Task Group first met on 28 July 1993 to identify issues to be included in the monitoring plan and then subsequently reviewed a series of draft plans that were written by members of the Task Group. The following report, "A 5-Year Plan for Research and Monitoring of the Eastern North Pacific Population of Gray Whales", until accepted by the Assistant Administrator of NMFS, represents the opinions and recommendations of the Gray Whale Monitoring Task Group. Much of the text in the plan was taken directly from the final rule publication.

Howard W. Braham (Chair)
Douglas P. DeMaster (Vice-chair)

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

EXECUTIVE SUMMARY

The National Marine Fisheries Service (NMFS) is required under the Endangered Species Act (ESA Section 4(g)) to implement a plan to monitor the status of any species that has recovered and been removed from the List of Endangered and Threatened Wildlife (the List). The NMFS issued a proposed determination on 22 November 1991 (56 FR 226) that the eastern North Pacific population of gray whale should be removed from the List. The NMFS issued their final determination on 7 January 1993 (58 FR 3121), but concurrence from the U.S. Fish and Wildlife Service, Department of the Interior, including a final ESA determination and clearance, has not as yet been given.

Under the 1988 amendments to the ESA, the NMFS has the responsibility to monitor the status of the eastern North Pacific gray whale for a period of at least five years following delisting. If at any time during this period the Secretary of Commerce finds that the species' well-being is at risk, the ESA (section 4(b)(7)) provides that emergency protective regulations shall be issued to ensure the conservation of any recovered species.

This document describes the program NMFS has developed, for at least the next five years, to meet its mandate concerning monitoring the status of gray whales. The plan was developed by the staff of the National Marine Mammal Laboratory in coordination with the NMFS Gray Whale Monitoring Task Group of scientists and managers who have specific responsible for coordinating activities on gray whales. The Task Group was asked to develop a plan, monitor research activities after the plan is implemented, and also to serve as a quick response advisory team in the event of any catastrophic event impacting gray whales.

The following list of ranked priority research is recommended for the first 5-year monitoring plan:

1) Estimate abundance from biennial surveys (or other appropriate sampling period) during the southbound migration;
2) Estimation of calf production during the northbound migration;
3) Research to determine potential biases in methods used to estimate abundance and calf-production;
4) Research to determine trends in pregnancy rates from animals taken in the subsistence harvest;
5) Estimation of number of animals killed for subsistence purposes;
6) Use Bayesian synthesis to evaluate current status of the population;
7) Research to determine the degree to which anthropogenic effects (e.g., chemical contaminants, marine noise, etc.) may compromise the viability of this population (including its habitat).

In addition, the NMFS proposes to conduct cooperative studies with the government of Mexico on the use of lagoons and coastal waters of Baja California and mainland Mexico for calving and breeding. Finally, NMFS will monitor compliance of whale watching regulations by U.S. citizens and will encourage the governments of Mexico and Canada to use similar standards for whale watching within their waters.

PART I: STATUS AND RECOVERY

A. INTRODUCTION

Background

The Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.) is administered jointly by the U.S. Fish and Wildlife Service (FWS), Department of the Interior, and NMFS. NMFS has jurisdiction over most marine species and makes determinations under section 4(a) of the ESA as to whether the species should be listed as endangered or threatened. The FWS maintains and publishes the List of Endangered and Threatened Wildlife (the List) in 50 CFR part 17 for all species determined by NMFS or FWS to be endangered or threatened. A list of threatened and endangered species under the jurisdiction of NMFS is contained also in 50 CFR 227.4 and 50 CFR 222.23(a), respectively.

Section 4(c)(2) of the ESA requires that, at least once every 5 years, a review of the species on the List be conducted to determine whether any species should be (l) removed from the List; (2) changed in status from an endangered species to a threatened species; or (3) changed in status from a threatened species to an endangered species. NMFS completed its first 5-year review on the status of endangered whales in 1984 (Breiwick and Braham 1984). Based upon that status review, NMFS concluded that although no longer in danger of extinction, because of restricted calving grounds and coastal habitat which is being subjected to increasing development, the eastern Pacific gray whale (Eschrichtius robustus) stock should not be delisted but should be listed as threatened (49 FR 44774, November 9, 1984). No further action was taken, however.

On January 3, 1990 (55 FR 164), NMFS announced that it was conducting status reviews on certain listed species (including the gray whale) under its jurisdiction, and solicited comments and biological information. That status review was completed and made available to the general public on June 27, 1991 (56 FR 29471). The Federal Register notice also stated that NMFS intended to publish a proposed determination that the listing status of the eastern North Pacific population of gray whale should be changed. That proposed determination and rule was completed and published in the Federal Register on November 22, 1991 (56 FR 58869).

In the proposed rule, NMFS gave notice that the comment period would close on January 21, 1992. However, as provided under section 4(b)(5)(E) of the ESA, NMFS received and accepted a request for a public hearing on the proposal (57 FR 3040, January 27, 1992). Public hearings were held in Silver Spring, Maryland, on February 14, 1992 and Long Beach, California on February 25, 1992. The comment period was extended until March 6, 1992 (57 FR 2247, January 21, 1992) in order to allow the public sufficient time to attend the hearings and complete their written comments.

NMFS published the final rule on 7 January 1993 (58 FR 3121) and determined that the eastern North Pacific stock of gray whale should be removed from the list of Endangered and Threatened Wildlife. This determination was based on evidence that this stock has recovered to near its estimated original population size and is neither in danger of extinction throughout all or a significant portion of its range, nor likely to again become endangered within the foreseeable future. In this notice, NMFS reiterated its position that the western stock of gray whale has not recovered and should remain listed as endangered.

In accordance with section 4(a)(2) of the ESA, NMFS requested the concurrence of the Department of the Interior on this proposal when it was published on November 22, 1991. Concurrence on the proposal was received in a letter dated March 4, 1992. As the FWS maintains and publishes the List in 50 CFR part 17 for all species determined by NMFS or FWS to be endangered or threatened, the FWS is encouraged to promulgate a rule amending the List by removing the "gray whale" and replacing it with the "Western Pacific (Korean) gray whale". Upon completion, NMFS will implement a rule to remove the gray whale from the list of species found in 50 CFR 222.23. NMFS encourages the FWS to take timely action on this request and will assist the FWS to the greatest extent possible.

Mandate for Monitoring under the ESA

Section 4(g) of the ESA requires that whenever a species is removed from the List, the Secretary (in this case, of Commerce) implement a system, in cooperation with the states, to monitor the status of any species that has recovered to the point where the protective measures provided under the ESA are no longer necessary. This monitoring program must continue for at least 5 years.

Objectives of the Monitoring and Research Program

The primary objective of the monitoring and research program described in this report is to describe the information needed to document changes in the status and viability of the eastern stock of North Pacific gray whale between 1993 and 1998. Further, NMFS intends, as part of the monitoring plan, to revaluate the status of this stock at the end of this five year period. Finally, the NMFS intends to conduct research to better define the optimal sustainable population (OSP) level.

B. NATURAL HISTORY

Distribution

The gray whale is confined to the North Pacific Ocean. Two stocks occur in the North Pacific: the eastern North Pacific or "California" stock, which breeds along the west coast of North America, and the western Pacific or "Korean" stock which apparently breeds off the coast of eastern Asia (Rice 1981).

Most of the eastern North Pacific stock spends the summer feeding in the northern Bering and southern Chukchi Seas (Rice and Wolman 1971, Rice et al. 1984). In the northwestern Bering Sea, they have been noted in recent years to be extending their range west of Cape Olyutorisky on the Chukchot Peninsula. Unless this is an artifact of increased observation effort, gray whales may be extending their range in search of additional food resources. In the Beaufort Sea, sightings have been made of individuals as far east as long. 130°W during August (Rugh and Fraker 1981). In the East Siberian Sea, gray whales were found along the Siberian coast as far west as 174°08'E in late September (Marquette et al. 1982). Berzin (1984) reported this species is probably limited by pack ice in the summer. Although actual timing depends upon feeding conditions and patterns of ice formation, during October and November the stock begins leaving the Chukchi Sea (Braham 1984). Moving at about 125 km/day (Braham 1984), they exit the Bering Sea through Unimak Pass, Alaska, mainly in November and December (Rugh and Braham 1979, Braham 1984, Rugh 1984).

The whales migrate near shore along the coast of North America from Alaska (92% pass within 1.6 km of Cape Sarichef, Unimak Pass, Alaska- Rugh 1984) to the central California coast (most whales pass within 2.7km of the Monterey-Point Sur area- Rugh et al. in press). After passing Point Conception, California, Rice et al. (1984) reported the majority of the animals take a more direct offshore route across the southern California Bight to northern Baja California. This route passes Santa Rosa and San Nicolas islands, the Tanner and Cortes banks and into Mexican waters (MMS 1992). Other routes include the nearshore route which follows the mainland coast of California, and the inshore route which passes through the northern Channel Island chain to Santa Catalina or San Clemente Island and on into Mexico. Bursk (1988) suggested that gray whales have moved further offshore recently. Graham (1989) estimated that 14, 15, and 25 percent of the estimated population size passed west of San Clemente Island during the southbound migration in 1986/87, 1987/88 and 1988/89, respectively. Off California, southbound migrating gray whales swim at about 5.5 - 7.7 km/hour, and thus travel about 132 - 185 km per day with day and night speeds not statistically different (Pike 1962, Jones and Swartz 1987, Swartz et al. 1987).

Migrating gray whales are temporally segregated according to sex, age, and reproductive status (Rice and Wolman 1971). During the southward migration, the sequence of passage off California is as follows: Females in late pregnancy, followed by females that have recently ovulated, adult males, immature females, and then immature males (Rice et al. 1984). The mean pod size reported by Buckland et al. (1993a) for the southward migration was 1.96 (SE = 0.020). The earliest southbound migrants (mostly late-pregnant females) usually travel singly, whereas later migrants usually are in pods of two or more. The mean pod size through Unimak Pass is about two (Rugh 1984).

The eastern Pacific stock winters mainly along the west coast of Baja California. The pregnant females assemble in certain shallow, nearly landlocked lagoons and bays where, after an average gestation period of 418 days (Rice et al. 1981), the calves are born from early January to mid-February. The majority of gray whales in Baja California (including some cows with calves) spend the winter outside the major breeding/calving lagoons along the outercoast apparently from Bahia de Sebastian Vizcaino to Boca de las Animas. Research indicates that females with calves do not necessarily restrict themselves to a single lagoon, but may move between and among lagoons and the outer coast during the winter (Jones and Swartz 1984). While calving was assumed to occur only rarely during the southbound migration north of Baja California (Rice and Wolman 1971), more recently, Swartz (1990) noted that in the Channel Islands "calves of the season comprised 13.3% of all whales counted..." These observations suggest that calves may be born as far north as Washington State (Jones and Swartz 1987). A few calves are also born on the eastern side of the Gulf of California at Yavaros, Sonora, and Bahia Reforma, Sinaloa, Mexico (Gilmore 1960; Gilmore et al. 1967).

The northbound migration generally begins in mid-February and continues through May with the earliest northbound migrants passing San Diego before the last of the southbound migrants (Rice et al. 1981). By April, the early migrating whales begin showing up in the southern Bering Sea, which they enter through Unimak Pass. This migration is coastal, at least to the east of central Bering Sea (Braham 1984). Most of the animals in Alaska travel within one km of the coast, avoiding embayments, especially in the southeastern Bering Sea, and at least some apparently feed during migration (Braham 1984). However, because suitable feeding habitat is relatively uncommon south of the Bering Sea, few gray whales remain south of Unimak Pass to spend the summer along the west coast of North America (but see Nerini 1984). During the northward migration, the sequence is as follows: (1) newly pregnant females, followed by (2) other mature females, adult males, immature males and females, and (3) cows with calves. The latter are the last animals to leave the lagoons (Rice et al. 1984) with a more protracted period of migration (Poole 1984, Swartz 1990). On the northern grounds, primary feeding locations appear to be in the Chirikov Basin, the north side of the Chukchi Peninsula, nearshore waters of the western Bering Sea, and the southern capes of

St. Lawrence Island (Nerini 1984). These benthic foraging areas are all underlain by dense infaunal communities of crustaceans (Nerini 1984).

The western Pacific stock formerly occupied the northern Sea of Okhotsk in the summer, as far north as Penzhinskaya Bay, and south to Akademii and Sakhalinskiy Gulfs on the west and the Kikhchik River on the east. Southbound whales migrated along the coast of eastern Asia from Tatarskiy Strait to South Korea (Rice and Wolman 1971) to winter breeding/calving grounds, which probably lie along the coast of southern China in Gwangxi and Gwangdong provinces, and around Hainan Island (Wang 1984). Until the turn of this century, another migration route led down the eastern side of Japan to winter grounds in the Seto Inland Sea, Japan (Omura 1974). The status of the western Pacific stock of gray whales is uncertain (Brownell and Chun 1977). Sightings of 24 animals in the Okhotsk Sea and nine off the tip of Kamchatka in 1983 (Blokhin et al. 1985, Votrogov and Bogoslovskaya 1986), and 34 in 1989 in the Okhotsk Sea (Berzin in press) indicate that the size of this stock is small. There is no evidence that it has reoccupied its entire former range (Omura 1984). However, the initial stock size may have been only a few thousand (Omura 1988). Although Rice et al. (1984) concluded that it is likely that the stock is below a critical population size sufficient for recovery and may be almost extinct, Berzin (in press) suggested that the stock may be increasing slowly.

The gray whale formerly occurred in the North Atlantic, but has been extinct there for several centuries (Mead and Mitchell 1984).

Status of Stock

Because it uses coastal habitats extensively, the gray whale was especially vulnerable to shore-based whaling operations and both stocks were severely depleted by the early 1900s. Under legal protection since 1946, the eastern North Pacific stock has recovered to its estimated original, pre-commercial exploitation population size (Rice et al. 1984), but apparently remains below the ecosystem's carrying capacity for that stock (Reilly 1992). A comprehensive assessment and review of the status of the gray whale was carried out by the Scientific Committee of the International Whaling Commission in 1990 (see Braham and Donovan in press).

Recently however, Reilly (1992) stated that it is not entirely clear where the population is in relation to its current carrying capacity. He noted that if early aboriginal kills were 50 percent higher than documented, estimates of carrying capacity would range from 23,000 to about 35,000 and the population would be between 60 percent and about 90 percent of carrying capacity. However, Reilly (1992) noted also that the possible recent decline in pregnancy rates (Fig 1, see also IWC 1990) and possible signs of overexploitation of the benthic fauna upon which gray whales feed in the Bering and Chukchi Seas (see also Stoker 1990, IWC 1990), if verified, may be evidence that the stock is nearing the limits of its environment and therefore approaching carrying capacity.

Another indication that the stock may be approaching carrying capacity is the increased observation of females with newborn calves in areas outside the calving lagoons, especially during the southbound migration (Jones and Swartz 1989, Swartz 1990, Sund 1975). Alternatively, the fact that the calving lagoons do not appear to be saturated (Swartz 1990) may indicate that gray whales continue to reoccupy their former range. Therefore, it is likely that the calving lagoons are neither a factor limiting the increasing size of the gray whale population, nor, considering their geologically transient nature, as critical a component of the gray whale's habitat as previously assumed (see for example, Rice et al. 1984 and 49 FR 44774, November 8, 1984). None the less, data on the mortality rate of newborn calves outside the calving lagoon environment in comparison to mortality within the lagoons (approximately 5%, Swartz and Jones 1983) are needed to verify this hypothesis.

Abundance and Population Trends

The most recent estimate of abundance is from the southbound migration during the winter of 1987/1988. Buckland et al. (1993a) estimated abundance at 20,869 (se = 688) . This is greater than Henderson's (1972, 1984) estimated initial (1846) stock size of 15,000 - 20,000, but below Reilly's (1981a) estimate for carrying capacity of 24,000 gray whales. Using Reilly's (1981a) estimate of carrying capacity with Buckland et al.'s (1993a) estimate of population size, it is likely that the gray whale population is within its optimum sustainable population (OSP, i.e., a range of population sizes between 60% of carrying capacity and carrying capacity) at about 87 percent of estimated historic carrying capacity (20,869/24,000 = 0.87).

The eastern Pacific stock has increased (Fig 2) in spite of increased human use of the coastal habitat and an average subsistence catch of 174 whales per year by the former Soviet Union during the past 30 years (calculated from unpublished data from Ivashin, 1990). The estimated rate of increase (Breiwick et al. 1989, Buckland and Breiwick in press) between 1968 and 1988 was 3.3% per year (95% CI: 2.3 - 4.2%, CV= 0.04). The combination of a sustained increase in abundance during a period of sustained catches indicates a potential for recovery of 4% per year (Reilly 1992).

C. FACTORS INFLUENCING THE POPUALTION

Section 4(a)(1) of the ESA and the NMFS' listing regulations (50 CFR part 424) set forth procedures for listing, reclassifying or removing species. The Secretary of

Interior or Commerce, depending upon the species involved, must determine if any species is endangered or threatened based upon any one or a combination of the following factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; or (E) other natural or man-made factors affecting its continued existence. Under section 4(a)(2) of the ESA, if the Secretary of Commerce determines that a species under her/his jurisdiction should be removed from the List or changed in status from endangered to threatened, the Secretary then recommends such action to the Secretary of Interior. If the Secretary of Interior concurs with the action, the List is amended. However, if a species is removed from the List, the Secretary, under section 4(g) of the ESA, must implement a system in cooperation with the states to monitor effectively for a period not less than 5 years the status of the species and must use the emergency authority provisions under paragraph (b)(7) of section 4 to prevent a significant risk to the well-being of any recovered species. These factors and subsequent consultation with the Department of the Interior are discussed below.

Factor (A)-- <u>Present or Threatened Destruction, Modification or Curtailment of Its Habitat or Range</u>.

Two potential threats to the eastern North Pacific stock of gray whale are increasing vessel traffic (including whale watching activities) and industrial development (including oil and gas exploration and development).

a. Vessel Traffic

Under the MMPA, gray whale harassment is considered a "take" and is prohibited. In 1993, NMFS has established guidelines for whale watching in order to avoid harassment of gray whales on their migration path in U.S. waters and may implement regulations to limit approaches to marine mammals. In this regard, a proposed rule was published on August 3, 1992 (57 FR 34101) and the comment period expired on December 31, 1992. Although these proposed regulations were subsequently withdrawn on 29 March 1993 (58 FR 16519), if revised regulations*apa* or guidelines are implemented in the future, these regulations would be effective within waters under U.S. jurisdiction and for U.S. citizens except when within waters under the jurisdiction of another nation (<u>e.g.</u>, Canada and Mexico). Revised regulations could establish minimum approach distances for large cetaceans and procedures to avoid disrupting the normal movement or behavior of marine mammals. It is anticipated that these regulations would strengthen protective measures for gray whales principally during migratory periods.

Commercial vessel traffic may result in the death of gray whales through collision or by harassment when both vessel and whale are confined to narrow passages. Heyning and Dahlheim (in press) documented 7 cases of gray whale/ship collisions; 5 in southern California, one each in Alaska and Washington They surmised that gray whales may be unable to detect large ships in time to avoid collisions due to the size and speed of the vessels. However, because large vessels are restricted to certain travel lanes while in inshore waters (where gray whales are predominantly located) and the low period of vulnerability to large commercial vessels due to the whale's migratory nature, NMFS believes that few gray whales are killed annually by collisions with vessels.

Activities of commercial cruise boats and small pleasure craft may result in harassment of gray whales, especially in the breeding/calving lagoons in Baja California and along their migration route off California. As whale-watching activities increase rapidly in southern California and on the Baja Peninsula, harassment occurrences are increasing proportionally, particularly on weekends and holidays. Whale watching by recreational and commercial craft may negatively impact migrating gray whales by interrupting swimming patterns, altering migratory routes, and displacing cow/calf pairs from inshore waters, thereby increasing energy consumption (CMC/NMFS 1988, IWC 1990). Bursk (1988) suggested that gray whales have moved further offshore recently due to whale-watching activities in southern California. Graham (1989) has noted a similar decrease in nearshore gray whales, but attributed it to sea surface temperature anomalies in late 1988/early 1989. Rice and Wolman (1971) considered the offshore passage to be a commonly used migratory route.

Gray whales in the breeding/calving lagoons have been reported to react to vessels moving at high speeds or erratically; however, gray whales show little response to slow moving or anchored vessels (Jones and Swartz 1984). Further, it has been reported that gray whales avoid vessels at ranges of roughly 0.5 km and less, with no documented responses at further distances (IWC 1990). It is likely that this "avoidance" distance varies with season and area. For example, Jones and Swartz (1984), in a study of gray whales in Laguna Bahia San Ignacio, reported that gray whales possess sufficient resiliency to tolerate the physical presence and activities of whale-watching vessels and skiffs and the noise produced by this level of activity without major disruption. This finding was supported by a noted increase in usage of the lagoons by gray whales, especially females with calves. Jones and Swartz (1984) believe a key factor responsible for maintaining a stable population within their study lagoon (i.e., San Ignacio) was: (1) the establishment of the gray whale refuge, which provided an area free of all vessel activity to which whales could retreat and (2) the behavior of commercial whale watch operators to minimize disturbance.

The main gray whale calving grounds in Mexico are Laguna Ojo de Liebre (Scammon's Lagoon with 53 percent of calves), Estero Soledad (12 percent), Laguna San Ignacio (11 percent) and Laguna Guerrero Negro (9 percent) in Mexico

(Rice et al. 1984). However, the number of whales present at any one time is subject to fluctuations due to the interchange of whales between the lagoons, between the lagoons and the coastal waters, and because of the sequential departure of animals for the northward migration (Jones and Swartz 1984). Minor calving areas, each with less than 6 percent of the calves, are San Juanico Bight, Bahia Magdalena, Bahia Almejas, and Bahia Santa Marina (Rice et al. 1981, 1984). A few calves are also born on the eastern side of the Gulf of California at Yavaros, Sonora, and Bahia Reforma, Sinola, Mexico (Gilmore 1960, Rice et al. 1984). Between 1972 and 1979, the Mexican Government designated three (Laguna Ojo de Liebre, Laguna Guerrero Negro, and Laguna San Ignacio) of the four major calving lagoons in Baja California as gray whale refuges. These are the lagoons that most of the U.S. tour boats and private tourists visit. The number of vessels allowed in these lagoons at any one time is limited by a permit system, which is run by the government of Mexico. Further, entry into certain areas, such as the upper lagoon in Laguna Ojo de Liebre and the middle and upper lagoons in Laguna San Ignacio (Jones and Swartz 1984), is forbidden. Apparently, because of Mexico's policy of revoking permits if there are any transgressions, this system is generally effective (Stinson 1988). However, Jones and Swartz (1984) found that in Laguna San Ignacio, where regulations limit the number of vessels to two at any one time, 3 or 4 vessels may occupy the lower lagoon for about 1/2 day when departing vessels overlap with arriving vessels.

To provide additional protection of gray whales within Mexican waters, the Government of Mexico has implemented its own standards for governing whale watching activities.

b. Industrial Development

b.1. Oil and Gas Exploration

A second potential threat to the eastern North Pacific stock of gray whale is oil and gas exploration and development and related activities along its migration route, in the breeding/calving lagoons in Baja and in or near its feeding grounds in the Bering and southern Chukchi Seas. Oil and gas exploration, which may result in a short-term loss of habitat for gray whales through displacement by seismic and other activities, is contemplated or under way on the outer continental shelf (OCS) from California to the Beaufort Sea, and west into Russian waters of the Bering Sea. In addition, other types of mineral resource development (e.g., gold mining) are under consideration within gray whale feeding areas in the Bering Sea. Annually, the gray whale population migrates by or through at least eight oil lease areas within U.S. waters (Rice et al. 1984).

Between 1964 and 1989, over 358 exploration and 692 development wells, have been drilled on the Pacific Region OCS (MMS 1992). All of the development wells and all but 31 of the exploration wells were in the Southern California Bight.

In Southern California, 21 platforms have been installed and approximately 135 miles of pipeline have been laid in Federal waters. There are no platforms or pipelines in the central California, northern California, and Washington-Oregon OCS.

Nominal exploration and development work will continue in Southern California as the number of leases has dropped dramatically to only 116 as of July 1990 (MMS 1991). MMS (1992), for its baseline studies, anticipates that in southern California, approximately 3-4 exploratory and/or delineation wells could be drilled annually, for a total of 25 wells over an eight year period. Approximately 7 development platforms (and pipelines) would be built under this scenario. It appears that only two large and ongoing development projects, the Point Arguello Field and the Santa Ynez units will be placed into production within the next 5 years (MMS 1991). Oil and gas development will likely result in long-term activities. However, the loss of habitat for gray whales in California due to seismic and drilling operations is likely to be relatively minor.

In Alaska, 87 wells have been drilled, including 2 ongoing wells in the Chukchi Sea and 14 test wells. Thirty-three wells were drilled in the Gulf of Alaska, 30 in the Bering Sea, and 24 in the Arctic. None of these wells resulted in the discovery of hydrocarbons in commercially producible amounts. However, while subeconomic, eight wells demonstrated the positive hydrocarbon bearing potential of the Beaufort Sea area (MMS 1991).

At this time there does not appear to be a high degree of industry interest in the Gulf of Alaska/Cook Inlet area and unless new leases are issued, there will be little operational activity in that area in the next 5- to 10-year period (MMS 1991). Past drilling activity in the St. George, Norton and Navarin Basins has not resulted in any announced discoveries of oil or gas and leases in the North Aleutian Basin have been suspended pending completion of congressionally mandated studies. Although there may be some scattered exploratory activity on existing leases in the St. George, Norton and Navarin Basins, any production is at least 10 to 15 years away, even if a major field were to be discovered (MMS 1991). If a major field is not discovered, little activity would be expected because of the high costs involved and the unproven geologic potential of the area.

In the Chukchi Sea, it is likely that 2 to 3 exploration wells will be drilled each year for the next 5- to 10-year period contingent on results of early wells. One or more major discoveries might accelerate activity while few or no discoveries will curtail activity. While there are some significant discoveries of oil and gas in the Beaufort Sea, whether or not they are developed further may well depend on new discoveries to support the enormous costs of the infrastructure needed to produce and transport oil and gas from Alaska (MMS 1992).

No new lease sales are proposed for Washington, Oregon, or central and northern California before 1997. In southern California no lease sales are contemplated until at least 1996, when 86 blocks in the Santa Maria Basin and Santa Barbara Channel will be considered (MMS 1991). In Alaska, two lease sales in the Beaufort Sea (1993 and 1996), two for the Chukchi Sea (1994 and 1997), two in the Bering Sea (1995 and 1996) and one each in Cook Inlet (1994) and Gulf of Alaska (1995) are proposed, although several additional sales are possible (MMS 1991).

On the winter breeding/calving grounds, oil and gas exploratory areas include sites within and adjacent to present calving and nursery areas, such as the offshore waters of Sebastian Vizcaino Bay, where seismic exploration for gas deposits took place during 1981. To date, no development activities are known to be underway but may take place in the future.

Potential impacts from industrial (or other) development include noise disturbance, contact with spilled oil, habitat degradation and possible loss or destruction of benthic prey populations upon which gray whales depend.

b.2. Noise Disturbance

Noise disturbance to gray whales has been studied during their migrations along the California coast (Malme et al. 1983 and 1984) and on their breeding/calving grounds in Baja California Sur, Mexico (Dahlheim 1983, 1984; Dahlheim et al. 1984). Reactions of gray whales to recordings of industrial noise and to a seismic airgun source during migration have shown that avoidance behavior occurs only at relatively close ranges at decibels greater than 120 dB for continuous noise and 160-170 dB for pulsed sounds such as from airguns (Tyack 1988). Malme et al. (1984) for example, found a 50 percent probability of an avoidance response of 2.5 km off central California for a seismic airgun array, 1.1 km for a drillship, and 400 m for a single airgun. However, because noise from oil and gas activities occurs at frequencies that overlap gray whale calling (and assumed hearing, see Dahlheim 1988b and Dahlheim and Ljungblad 1990) frequencies, they may also influence other behavior causing, for example, interference with socialization, reproductive behavior and communication. For oil and gas activities subject to U.S. jurisdiction, NOAA requires companies under an MMPA 101(a)(5) Small Take Letter of Authorization to take specified precautions to avoid disturbing whales, including gray whales.

Reactions of gray whales exposed to recordings of industrial noise, biological sounds (e.g., killer whale vocalizations), and novel sounds (e.g., pure tones) in their breeding/calving grounds were more pronounced than those reported off central California (Jones et al. 1991, Dahlheim 1988a). Dahlheim (1988a, b) reported that gray whales responded to vessels and to playbacks of vessel noise by increasing their calling rate, frequency modulation of calls, number of pulses per call-series, and repetition rates. Further, gray whales moved, both away from and toward the sound source. In response to a playback of oil drilling noise, callingpa rates were reduced, direct movements away from the sound source were documented, milling rates decreased, and a decrease in local whale abundance were documented. Dahlheim (1988b) hypothesized that gray whales engaged in acoustical communication circumvented noise in the acoustical channels used for communication by shifting the frequency structure and timing of their calls.

Gray whales may also be sensitive to noise disturbance on their feeding grounds and might temporarily abandon productive feeding areas if excessively disturbed. MMS (1992) reported that most seismic exploration activities off the Alaskan coast would take place from June to September, the same time period gray whales occupy their northern feeding grounds. Reliance on less-productive areas could leave the animals with insufficient body reserves for their successful migration and reproduction. However, because of the apparent abundance and range (one million km^2) of the gray whale's primary food source in the Bering Sea, the present gray whale population would not be adversely affected by the short-term and non-recurring local impacts brought on by seismic exploration (NMFS Biological Opinion for Lease Sale 100, dated December 21, 1984).

b.3. Contact with Oil and Related Hydrocarbons Following Oil Spills

Another potential threat is the possibility of a major oil spill that would affect a large portion of the gray whale population and/or its habitat; although the temporal and spatial segregation of the stock would tend to expose different segments of the population to oil at any given time. Assuming an oil spill, caused either by a tanker accident, pipeline break, or an oil well blowout, were to occur and contact gray whales, the adverse impacts to whales from contact would include death or illness caused by ingestion or inhalation of oil, irritation of skin and eyes, fouling of feeding mechanisms, and reduction of food supplies through contamination or losses of food organisms. Although no data exist at this time, additional effects include: (1) conjunctivitis and corneal eye inflammation leading to reduced vision and possible blindness; (2) development of skin ulcerations from existing eroded areas on the skin surface with subsequent possibility of infection; (3) compromisation of tactile hairs as sensory structures; and (4) development of bronchitis or pneumonia as a result of inhaled irritants (Albert 1981). In general, however, the results of Geraci and St. Aubin (1982, 1985) and Geraci (1990) indicate that whales are likely to suffer only minor impacts if they contact oil spills,pap and that they are likely to recover from these effects. It is recognized that natural oil seeps have long been a part of the ecosystem that gray whales inhabit. In southern California for example, there are 54 natural seeps, with an approximate discharge of 30,000 tons (7.03 X 10^6 gal.) released annually in the Santa Barbara Channel alone (Fischer 1978 as cited in Neff 1990a). Studies on gray whales in these seeps (Evans 1982), and on bottlenose dolphins in an experimental setting (Geraci 1990), although inconclusive, tend to indicate that cetaceans can detect oil on the surface. When entering oil-contaminated environs, gray whales tend to spend less time on the surface, blowing less frequently, which may be interpreted as an avoidance behavior, although more testing would be necessary to verify the observation (Geraci 1990). The inhalation of the hydrocarbon products at the water surface is believed unlikely because the breathing mechanism of the whale which prevents inhalation of water would likely also prevent inhalation of oil (Geraci and St. Aubin 1980). However, if the whales enter the immediate vicinity of a recent spill, toxic fumes could be inhaled, although 50 percent of the aromatic hydrocarbons (e.g. toluene and benzene) evaporate within a few days of the discharge (Neff 1990a), reducing the toxicity in the spill area (but see Loughlin in press) for arguments to the contrary).

Because the probable effects on whales from contacting oil include temporary fouling of baleen and toxic effects from ingestion of oil, oil spills may pose a greater problem for the gray whale on its feeding grounds than during its migration. In a laboratory study on bowhead whales (Balaena mysticetus), baleen plates fouled by oil had decreased filtering efficiency for at least 30 days, but 85 percent of the efficiency was restored within 8 hours (Braithwaite et al. 1983). Due to its coarser and shorter baleen, Geraci and St. Aubin (1982, 1985) demonstrated similar, but somewhat faster, recovery rates for gray whales. Although the toxic effects of ingesting oil remain generally unknown, Geraci and St. Aubin (1990) believe that marine mammals have the liver enzymes required to metabolize and excrete hydrocarbon compounds. This ability limits the accumulation of residues in body tissues; however, the biotransformation of certain aromatic compounds (ACs) present in petroleum to reactive metabolites is related chronic biological effects, such as cancer (Varanasi et al. 1989). The concentrations of carcinogenic ACs in petroleum are low, which may minimize the risk of chronic effects of exposure to carcinogenic ACs.

The results of computer simulations indicate that were an oil spill to occur in the Navarin Basin, it would likely not contact any gray whales; whereas, a spill in the Beaufort Sea, St. George Basin, and Chukchi Sea would be expected to contact fewer than 0.2%, 1.5%, and 0.8% of the population, respectively (Neff 1990b). In the St. George Basin, gray whales would contact oil from a spill while navigating to and from their feeding grounds in the spring and fall, while in the Chukchi Sea, they would contact oil during summer feeding months. No more than 1.5% of the whales passing through Unimak Pass would be expected to contact oil following a spill (Neff 1990b). In general, the results of the simulations indicate that there is a low (less than 10%) chance that gray whales would encounter oil following a spill in the Bering Sea during the 30- to 40-year lifespan of an individual oil field (Neff 1990b). MMS (1992) estimated the probability of one or more oil spills of 10,000 barrels or greater occurring in the range of gray whales to be 14% in southern California, 21-27% in the Bering Sea, 18-34% in the Gulf of Alaska, and 96% in the Chukchi Sea, provided commercially producible amounts of hydrocarbons are discovered and developed.

MMS (1992) gives the probabilities of one or more pipeline or platform spills of 1,000 bbl and greater, and 10,000 bbl and greater as a result of activity in the Chukchi Sea as 92 and 57 percent respectively. In addition, because Chukchi Sea oil will be transported by tanker, there is a 93 and 81 percent probability of one or more spills of 1,000 bbl or greater and one or more spills of 10,000 bbls or greater respectively occurring; although tanker spills would occur outside the Chukchi Sea area since all transport within the area will be by pipeline (MMS 1992). In areas such as the Norton, Navarin and St. George Basins, oil will be transported by tanker to shore facilities in Alaska or other West Coast states. For its base case projections, MMS (1992) predicts one tanker spill for each of these areas developed (over the 30- to 40-year life span of an oil field) but no platform or pipeline spills.

In southern California, MMS (1992) reported that the expected number of pipeline spills of 7,000 bbl resulting from exploration and development activities in the Santa Maria Basin or the Santa Barbara Channel is one. In addition, as a result of oil and gas activities in Alaska, 3 tanker oil spills of 30,000 bbl each are expected to occur along the tanker route on the Pacific coast over the 30- to 40-year life span of an oil field: one off Washington, one off northern California and one off southern California. Based on the simulation results, spills in northern California spill are expected to occur 80 km or more from the coast with no shore contact.

MMS (1992) anticipates that an oil spill of 10,000 bbl or greater in the Chukchi and Bering Sea could result in the death of a few individuals and the displacement of gray whales from areas of up to 1,500 km^2 of feeding grounds for all or part of a season. (For comparison purposes, the Chirikov Basin is approximately 3.7×10^4 km^2).

MMS (1991) reported that out of a total of 6.2 billion barrels of OCS oil produced from 1971 through 1988, only 900 barrels were spilled from blowouts. However, this statistic excludes the Union Oil spill in Santa Barbara in January 1969. That spill resulted in a loss of about 3 million gal of oil which eventually covered 2200 km^2. Surveys conducted as a result of that spill discovered 6 gray whales stranded between January 28 and March 31, 1969. Although these counts were higher than normal, it is unclear whether this was due to the spill or to the increased survey effort (Brownell 1971).

Based upon data resulting from the exploratory wells drilled in recent years in the Bering Sea, MMS (1992) has reevaluated and lowered its estimate of the potential for discovering an exploitable field in the Bering Sea. Based upon MMS' reanalysis, NMFS has determined that the expectation of an oil well blowout occurring and impacting gray whales is low. Essentially, in order for gray whales to be seriously impacted by an oil spill due to oil and gas exploration and development activities, the following events need to occur: (1) A lease sale takes place; (2) exploratory activities determine that economically exploitable quantities of oil can be recovered; (3) development occurs which (4) results in a blowout with a significant loss of oil and (5) the spilled oil intercepts a significant portion of the gray whale population or its food source.

Oil spills, the chemicals used to break up and sink surface oil, and other anthropogenic materials from either oil platforms, (such as drilling muds, discharged materials and produced water), or shore-side discharges from industrial, residential or agricultural point and non-point sources, could also harm gray whales by reducing or contaminating their food resources. Gray whales are opportunistic feeders on a wide variety of benthic ampeliscid amphipods and other bottom dwelling organisms (Nerini 1984). Most feeding takes place between May and September in the northern waters of the Bering and Chukchi seas, especially in the Chirikov Basin. Some food consumption also occurs during migration and a small portion of the population remains south of Unimak Pass, Alaska, to exploit that resource. Feeding by non-calf gray whales in and near the breeding lagoons is thought to be rare (Nerini 1984).

The feeding strategy of gray whales could lead to ingestion of oil from oil-contaminated food, if the prey organisms accumulate petroleum hydrocarbons in their tissue, or from contaminated sediments associated with food sources. The effect of pollutants on the benthic organisms on which these whales feed is relatively unknown, but may result in either direct mortality or sublethal effects that inhibit growth, longevity and reproduction. Benthic organisms do accumulate aromatic hydrocarbons and heavy metals (Landrum and Robbins 1990), and these substances could be transferred through the food web. According to sources cited in Neff (1990a), benthic crustaceans have a mixed-function oxidase (MFO) system to biotransform petroleum hydrocarbons. The capacity of amphipods to biotransform hydrocarbons can vary among amphipod species (Reichert et al. 1985). If the amphipods that are prey for gray whales have the ability to biotransform petroleum hydrocarbons efficiently then these hydrocarbons are less likely to persist and biomagnify in the gray whale food web. Another factor decreasing bioaccumulation may be the short life span of the amphipods (i.e., < 2yr). Therefore, gray whales may ingest petroleum hydrocarbons from their food source and as a process of feeding also incidentally ingest petroleum contaminated sediments (see also the earlier discussion on baleen fouling from sediment contamination). Further, benthic amphipods have proven to be quite sensitive to spilled oil and are among the first animals killed after an oil spill (Neff 1990a), which could in turn affect that portion of the gray whale stock feeding in the contaminated area. If they are unable to locate alternative areas with sufficient food resources, they may have insufficient reserves to make the 8,000 km migration to southern grounds, overwintering there and returning the following spring.

b.4. Other Sources of Contamination

Because discharges of drilling muds from offshore platforms may contain heavy metals and other contaminants, all discharges from platforms are regulated by EPA under section 402 of the Clean Water Act. EPA's proposed regulations recommend zero discharges of drilling muds and cuttings and filtration of produced waters. Drilling muds, however, are relatively non-toxic and the metals associated with drilling muds are virtually unavailable for bioaccumulation by marine organisms (Neff 1987). The National Research Council (1985) concluded that the risks to most OCS benthic communities from exploratory drilling discharges are small and result primarily from physical benthic effects. Because ampeliscid amphipods predominate in disturbed bottoms (Nerini and Oliver 1983, and Nerini 1984), are highly motile, and are good colonizers, and because amphipod recovery is likely to take place within 1 year (Oliver and Slattery 1985), NMFS believes that the gray whale's food source is unlikely to be impacted seriously by the establishment of platforms and pipelines in the OCS.

Preliminary results from a study by Varanasi et al. (1993) on contaminants found in gray whales stranded near Puget Sound indicated that heavy metal levels appear to be too low to cause any deleterious effects. In addition, the concentrations of PCBs and DDT were very low compared to levels in other whales and are below levels known to cause impairment. Analyses of 16 elements in liver, kidney and stomach contents of gray whales were generally low. However, high concentrations of aluminum (1,700 ±450 ppm), iron (320 ±250 ppm), manganese (23 ±15 ppm), and chromium (3.4 ±1.3 ppm), were discovered in stomachs, although no significant differences were observed between whales stranded in Puget Sound compared to whales stranded at more pristine sites. Varanasi et al. (1993) noted that the relative proportions of these 4 elements in stranded whales were similar to the relative proportions in sediments, which is consistent with a geological source of these elements from the ingestion of sediment during feeding. The results of their study suggest that the concentrations of anthropogenic chemicals in stranded gray whales show little relation to the level of pollution at the stranding site, and further, showed that the concentrations of potentially toxic chemicals were relatively low when compared to the concentrations in marine mammals feeding on higher trophic level species, such as fish. According to Brownell and O'Shea (in press), levels of organochlorine pollutants that may cause reproductive problems in other mammals are higher than those reported in baleen whales. In addition, the vast majority of the eastern

Pacific gray whale stock feeds mostly in colder waters that have been less exposed to organochlorine pollutants (IWC 1990).

Varanasi et al. (1993) also noted the lack of data from apparently healthy gray whales limits the understanding of the susceptibility of this species with respect to levels of anthropogenic contaminants found in tissues. At present there are only limited data on levels of these chemicals in tissues of gray whales or other baleen whales, such as the bowhead whale (Bratton et al. 1993). Therefore, additional baseline data are needed in order to assess temporal trends in levels of chlorinated hydrocarbons (CHs), in particular, and to provide a reliable assessment of the potential for toxicity of CHs in gray whales. Further, if feeding activities increase in coastal areas of the west coast, exposure to CHs would be expected to increase because previous studies have shown that levels of CHs are elevated in several of these areas compared to levels in Alaska waters (Varanasi et al. 1993).

b.5. Effects of Disturbance

Coastal development and coastal and offshore industrial activities may also result in some impacts to the gray whale and its habitat. For example, in the calving lagoon of Guerrero Negro, daily dredging and vessel traffic between 1957 and 1967 for a salt extraction plant reportedly caused the whales to abandon the area. In 1967, the plant was closed and moved to Laguna Ojo de Liebre (Bryant et al. 1984). Six years after the dredging and barge activity in Guerrero Negro ceased, gray whales began to return to the lagoon (Bryant and Lafferty 1980). Because the production of salt at Laguna Ojo de Liebre appears to have no adverse impacts on the biota of the lagoon (Rice et al. 1981), and because the whales appear to tolerate the daily salt-barge traffic and have not abandoned Laguna Ojo de Liebre, daily dredging and the associated vessel traffic in the more confined Guerrero Negro is more likely the cause of abandonment. In addition, exploitation of phosphorus (Cordoba 1981) and the development of a large resort in and near the minor calving lagoons of Bahia Almejas and Bahia Magdalena, if constructed, may be cause for concern. Because of the scarcity of suitable (i.e., isolated) calving and nursery areas for gray whales and the whales' specialized feeding habits, gray whales need to be monitored to determine the effects of future coastal or shallow-water development on any critical stages of the gray whale's life cycle that could cause them to utilize less preferred habitat.

The recovery of the gray whale population has occurred concurrent with extensive OCS geophysical exploration off the California coast and other activities throughout its range, and these levels of activity are unlikely to increase significantly in the near future. NMFS, therefore, concludes that current and anticipated levels of human activities do not pose a danger of extinction to this species now or in the foreseeable future. NMFS does not rule out the possibility that parts or all of this stock and certain components of its habitat have been and/or are being stressed or that the effects will not be manifested over time as changes in productivity, mortality or distribution.

Factor (B) -- Overutilization for Commercial, Recreational, Scientific or Educational Purposes.

As a result of commercial whaling operations, the gray whale was severely depleted by the early 1900s. After 1946, commercial harvesting of gray whales was banned by the International Convention for the Regulation of Whaling. Between 1959 and 1969, a total of 316 gray whales were killed under Special Scientific Permits off California. A significant amount of gray whale life history data came from these animals (see for example, Rice and Wolman 1971).

Eskimos living on the shores of the northern Bering Sea and the Chukchi Sea have hunted whales for perhaps several thousand years. Estimated aboriginal takes of the eastern Pacific stock prior to depletion of gray whales ranged from about 156 per year (years 1600-1750) to 186 per year (years 1850-1860) with a period high of 263 per year (years 1751-1850). Subsequent declines after 1850 were due to reductions in native populations, loss of traditional native cultures under the influence of Western society and reduction of the gray whale stock due to commercial whaling (IWC 1990, Mitchell and Reeves in press).

In Alaska recently, the catch consists mostly of bowhead whales, with few gray whales being intentionally taken (Marquette and Braham 1992). However, on the Chukotka coast of Russia, the catch has consisted almost entirely of gray whales. Since 1969, when the aboriginal hunt ceased as a result of a large number of "struck-and-lost" whales (Yablokov and Bogoslovskaya 1984), gray whales have been taken by the Russian Government for the Chukchi Eskimos using one modern catcher boat. The total aboriginal catch in Russia has averaged about 165 gray whales per year since 1967. The current catch limit set by the IWC is 179 per year, 10 of which the United States informed the IWC at the 1991 plenary session that "...it is not requesting and will not in future years request an allocation or use of 10 gray whales" (IWC 1992). In 1990, the Soviet Union requested a three-year extension of their quota indicating that this level would satisfy local needs (IWC 1992). This authorized catch of gray whales is believed to be well below the sustainable yield estimated to be approximately 670 (95 percent confidence: 490-850; IWC 1990) and therefore is not likely to be significantly impacting the stock.

The question has arisen whether non-Alaskan natives would, in the near future, pursue traditional whaling and sealing activities. To date, only the Makah Tribe of northwestern Washington State has expressed such an interest, but it is unclear at this time whether they would be interested in pursuing open-boat whaling or could satisfy subsistence and/or cultural needs by other means. For any Native American group to begin harvesting large whales, they would have to demonstrate a subsistence need and request through the Bureau of Indian Affairs that the U.S. Commissioner to the IWC petition that body for a portion of the subsistence quota for gray whales. Such a scenario is considered unlikely at this time.

The question of whether commercial whaling on gray whales would resume in the near future has also been raised. In order for commercial whaling to resume, the IWC would need to reclassify the gray whale as an "initial population stock" (see discussion elsewhere in the preamble), and terminate its whaling moratorium. NMFS concludes that current and anticipated uses for commercial, recreational, scientific or educational purposes do not pose a danger of extinction to this species now or in the foreseeable future.

Factor (C) -- Disease or Predation.

The annual mortality rate of the gray whale is low, approximately 0.056 for adults and 0.132 for juveniles (Reilly 1981b). There is no information indicating that disease or predation constitutes a threat to the continued welfare of the species.

The killer whale (Orcinus orca) appears to be the only non-human predator on gray whales. Evidence from the necropsy of 39 gray whales that stranded on St. Lawrence Island indicated that 16 had been killed by killer whales (Fay et al. 1978). The mortality rate from killer whale attacks is unknown. However, the frequency of tooth scars on gray whale carcasses indicates that killer whale attacks are often not fatal.

Moderate numbers of gray whale calves strand in and near the nursery lagoons and along the southern California coast (Swartz and Jones 1983). In addition, a few adults strand every year throughout their range, but the numbers appear low compared with the size of the population (Rice et al. 1984). While mortality rates due to stranding cannot be calculated (Rice et al. 1984), stranding data may provide insights into whether strandings are due to natural or anthropogenic factors.

In 1989, 29 gray whales were reported stranded in Alaska around the time of the EXXON VALDEZ oil spill from the area from Prince William Sound to the Alaskan Peninsula and into Bristol Bay; nine of those animals were reported stranded near the southern end of Kodiak Island, southwest and down-current of the oil spill area. While this number was significantly greater than earlier years when only six were documented between Kayak Island and Unimak Pass (Zimmerman 1989), this may be attributed to the timing of the search effort coinciding with the northern migration of gray whales augmented by the increased search effort in the oil spill area (Loughlin in press). In 1990, 26 stranded gray whales were counted off the southern end of Kodiak Island. Surveys of the other areas were not conducted that year. Although some gray whales were reported in 1989 to have oil on their baleen, apparently none had oil in the digestive tract (Moore and Clark as reported in IWC 1990). This is not unexpected considering that dead whales at sea generally float with the ventral surface up and the mouth open.

Recent strandings reported along the Washington/Oregon coast have also been higher than the mean for the past 2 years, but not higher than historic records (Heyning and Dahlheim in press). The majority of the animals stranding in Washington waters in 1990 and 1991 apparently died outside Puget Sound and were carried by currents to the outer coast of Washington and the Straits of Juan de Fuca.

NMFS concludes that disease or predation do not pose a danger of extinction to this species now or in the foreseeable future.

Table 1. Summary of stranding data along the Washington/Oregon coast.

Year	Number	Year	Number	Year	Number
1983	8	1987	9	1991	12
1984	15	1988	10	1992	3
1985	2	1989	4	1993	2*
1986	2	1990	15		

data from only part of 1993

Factor (D) -- Inadequacy of Existing Regulatory Mechanisms.

Existing laws and regulations are considered adequate for the conservation of the gray whale. Under the protection of the IWC, the MMPA and the ESA, the eastern North Pacific gray whale stock has recovered to near or above its estimated pre-commercial exploitation population size. Most of the protective measures for the gray whale would remain even without listing under the ESA. The gray whale would remain protected in the United States under the MMPA and the Whaling Convention Act, internationally under the International Convention for the Regulation of Whaling, as well as under national legislation in Canada, Mexico, and Russia.

Mexico has particularly detailed legislation protecting the calving lagoons from disturbance (Klinowska 1991). In 1972, 1975, and 1979 respectively, the Mexican Government designated the major calving lagoons of Laguna Ojo de Liebre, Laguna Guerrero Negro, and Laguna San Ignacio in Baja California as gray whale refuges. These refuges account for approximately 73 percent of calf productivity and are the lagoons that most of the U.S. tour boats and private tourists visit. The number of vessels allowed in these lagoons at any one time is limited by permit to two vessels at a time, and entry into the middle and upper (Ojo de Liebre and San Ignacio) and upper (Guerrero Negro) lagoon areas is forbidden from December 15 to March 15, although as documented by Jones and Swartz (1984) at Laguna San Ignacio, compliance is not absolute. Mexico issues individual permits to each vessel which specify the number of days a vessel may remain within the lagoon, the number of passengers it may carry, the number of skiffs it may launch and the kinds of activities permitted, such as whale watching, shore exploration, etc. (Jones and Swartz 1984). Violation of the permit requirements leads to a revocation of the permit. In order to provide additional protection for gray whales within Mexican waters, the Government of Mexico is in the process of implementing its own standards for governing whale watching activities.

Although unclassified in the "Red Book" (i.e. not listed as threatened) by the International Union for the Conservation of Nature (see Klinowska 1991), additional protection is afforded internationally under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES was created to prevent species from becoming threatened through international trade (Wells and Barzdo, 1991) and prohibits commercial trade in seriously threatened species, which are listed in CITES Appendix I. Trade in Appendix I species, such as the gray whale, may be authorized only in exceptional circumstances (e.g., scientific research), and provided the import is not for commercial purposes. All international shipments must be covered by an export permit from the country of origin and an import permit from the country of destination. There is no indication that any change in the gray whale's status under CITES is contemplated by any of its members and any change in status would require a majority vote of the member nations.

In the United States, regardless whether gray whales are delisted, activities that take marine mammals are prohibited unless authorized or exempted under the MMPA. The incidental take of marine mammals may be authorized in limited circumstances under an MMPA small take exemption. Oil and gas exploration activities, for example, are eligible to apply for a small take exemption under section 101(a)(5) of the MMPA. Under a Small Take Exemption, NMFS requires the oil and gas industry to take appropriate measures to minimize impacts to gray whales and to conduct exploration activities in such a way as to reduce the likelihood of adversely affecting the gray whale. The Letters of Authorization also include requirements for monitoring and reporting. For the 1991/92 exploration season, NMFS issued five Letters of Authorization (50 FR 47742, Sept. 20, 1991) but only one for the 1992/93 season. NMFS annually reviews the conditions under which these Letters are issued to ensure that gray whales, other marine mammals and their habitats remain adequately protected.

While section 7 consultations under the ESA would cease for the gray whale once the eastern stock is delisted, coastal habitat critical for the continued well-being of the gray whale would be protected within waters under the jurisdiction of the United States through other laws such as the National Environmental Policy Act, the Clean Water Act, MARPOL (the Anti-Dumping Act), the Marine Protection, Research and Sanctuaries Act (ocean dumping), sections 10 and 404 of the Rivers and Harbors Act of 1899 and the Oil Pollution Act of 1990 which will require, among other things, double-hulled tankers within U.S. waters by 2015. Consultations will also continue under the Outer Continental Shelf Lands Act Amendments.

NMFS concludes that the existing and anticipated regulatory mechanisms are adequate for the conservation of this species.

Factor (E) -- Other Natural or Man-made Factors Affecting its Continued Existence.

In addition to those man-made factors affecting the gray whale's continued existence which were discussed under Factors A and C above, gray whales are also impacted by incidental take in commercial fishing operations.

The fact that gray whales migrate in a narrow, nearshore corridor where commercial fishing activities are concentrated leads to encounters and entanglement in gear from several commercial fisheries. Norris and Prescott (1961) document entanglement in gillnets since the late 1950s. Data from the NMFS-administered stranding networks document that commercial gillnet fisheries take gray whales incidental to fishing. NMFS' Southwest Region has maintained records of reported gray whale entanglements in California gillnet fisheries since the 1984/85 migration. The number of entanglements has varied from a low of seven entanglements and no mortality during the 1985/86 migration to a high of 15 entanglements and three mortalities during the 1986/87 migration. The number of entanglements and deaths declined during the 1987/88 migration to seven entanglements and one mortality. This reduction in entanglements may have been due to regulations implemented by the State of California in the fall of 1987 that require fishermen to construct their nets so that whales can break through them and that prohibit fishing near major whale concentrations. However, no study was conducted to quantify the effectiveness of these regulations and the decline in entanglement could be due to natural variation. In 1990 and 1991, no gray whales were reported entangled in gillnet fisheries in California (Perkins and Barlow 1992).

It should be recognized that under the MMPA, the incidental taking of endangered, threatened or depleted species was illegal until 1989, making the fisherman subject to penalty. It is presumed that the potential for prosecution may lead to underreporting of incidental takings. In 1988, amendments to the MMPA authorized the incidental (but not intentional) taking of depleted species during commercial fishing operations under section 114 of the MMPA until October 1, 1993. Congress recently extended this authorization until 1 April 1994. However, under the ESA, takings of endangered species incidental to commercial fishing operations cannot be authorized under section 7 of the ESA, leaving the issue unresolved. The NMFS legislative proposal to Congress to govern fisheries after October 1, 1993 (see 56 FR 23958, May 24, 1991) proposes to authorize a limited incidental take of depleted, threatened or endangered species and to amend the MMPA to authorize takes incidental to commercial fishing activities under section 101(a)(5). Under that proposal, all provisions of the ESA would apply as well. That proposal, if implemented by law, however, would not likely result in an increase in gray whale mortality, because commercial fisheries would be regulated through seasonal, area or gear restrictions to reduce marine mammal mortality to insignificant levels approaching a zero rate. In addition, observers could be placed onboard vessels operating in any fishery that takes marine mammals and quotas would be enforced through fishery restrictions based upon observer reports.

The California Department of Fish and Game (CDF&G) observed one entangled balaenopterid (probably a minke whale, Balaenoptera acutorostrata) during 177 observer days spent monitoring the shark and swordfish drift net fishery in 1980. CDF&G's southern California set-net monitoring program monitored about 5 percent of the fishing effort from 1983 through 1986 and observed no gray whale entanglements (Collins et al. 1984, 1985, 1986; Vojkovich et al. 1987). Likewise, CDF&G set net observers in northern California reported no gray whale entanglements during monitoring of about 1 percent of the fishing effort from 1984 through 1987 (Wild 1985, 1986).

In the Pacific Northwest, gray whales have been observed entangled in salmon set-nets off northern Washington and in crab pot lines off Oregon. These entanglements are infrequent, occurring once every 1 to 3 years in the set-net fishery and once every 3 to 5 years in the crab fishery (NMFS 1991).

Heyning and Dahlheim (in press) reported on strandings and incidental takes of gray whales from Alaska to Mexico for the years 1975-1988. Gray whale strandings were examined carefully to document whether the animal had been entangled in fishing gear. Some known fishery kills of gray whales bore no evidence of entanglement after stranding, despite thorough examination (Heyning and Lewis 1990). Data from the Heyning and Lewis study indicate that (1) sexually immature animals represented 90 percent of all strandings; and (2) gray whale mortality related to fisheries interactions is likely insignificant relative to the present population size.

Minimal estimates of fisheries-related mortality for stranded gray whales ranged from 8.7 to 25.8 percent (Heyning and Dahlheim in press). None of the 20 animals documented in that report from Alaskan feeding grounds had indications of entanglement in fishing gear. In the Gulf of Alaska and Alaskan Peninsula area, four animals out of 29 (13.8 percent) that stranded were involved in fishing gear. Baird et al. (1990) reviewed the available information for British Columbia and found four animals out of 39 strandings (11.1 percent) were involved in fishing gear. They noted that if they included only the 15 strandings that were carefully examined, then 26.7 percent of mortalities were fisheries related.

The fisheries related mortality for Washington, Oregon and northern California are eight out of 50 (16 percent), two out of 23 (8.7 percent), and six out of 47 (12.8 percent), respectively. In southern California, more carcasses have been examined thoroughly and 25 out of 92 (25.8 percent) were mortalities related to fishing operations. Heyning and Lewis (1990) have reviewed baleen whale entanglements in this region and found that the majority of gray whale entanglements involved immature animals but not calves. Almost two-thirds of these entanglements occurred during the northbound migration.

Based upon the information acquired to date, but recognizing the scarcity of that information, NMFS concludes that gray whale mortality related to fisheries interactions is likely insignificant relative to the present population size.

NMFS concludes that there are no known or anticipated other natural or man-made factors that pose a danger of extinction to this species either now or in the foreseeable future.

PART II: 5-YEAR MONITORING PLAN AND IMPLEMENTATION

As part of its monitoring program, NMFS created an internal Task Group responsible for monitoring activities potentially impacting gray whales. This Task Group consists of NMFS marine mammal scientists familiar with either gray whale biology or related subject matter and will coordinate internal research on gray whales, encourage independent research in areas not currently funded or investigated by NMFS, and serve as a quick response advisory team in the event of any catastrophic event impacting gray whales. The Task Group will also recommend to the NOAA's Assistant Administrator for Fisheries appropriate steps necessary to mitigate any catastrophic event, including the reimposition of emergency protective measures. Finally, within 6 months following the conclusion of the first 5-year monitoring program, the Task Group will conduct a comprehensive "status review" of the gray whale that will be forwarded to the Assistant Administrator for approval and release to the general public for review and comment. The Task Group will review and address comments from the public in drafting a final report. Included in that report will be a recommendation on whether to (1) continue the monitoring program for an additional 5 year period; (2) terminate the monitoring program; or (3) consider changing the status of the gray whale under the ESA. In the intervening year between the conclusion of the first 5-year monitoring program and release of the final report, NMFS will continue with its monitoring program.

In addition to its required monitoring program, NMFS anticipates taking the following actions to ensure the continued well-being of gray whales:

(1) Evaluate and if necessary, propose revised whale watching regulations for U.S. citizens and others within the U.S. EEZ and promote with Mexico and Canada the use of similar standards for whale watching within their waters.

(2) To the extent possible, encourage MMS or other appropriate agencies to continue studies to determine the impacts of oil spills; vessel traffic, including noise; seismic exploration; and offshore drilling activities on gray whales and their benthic food resources. In addition, to the extent possible, coordinate research and monitoring activities with NOAA's Sanctuary Program Office concerning the following sanctuaries: Channel Islands National Marine Sanctuary, Monterey Bay National Marine Sanctuary, Gulf of the Farallones National Marine Sanctuary.

(3) To the extent possible, continue and promote increased cooperative studies with Mexico to monitor habitat use and the impacts of whale watching on the Mexican breeding/calving grounds; encourage the enforcement of gray whale sanctuary regulations in Mexico; encourage operators of U.S. whale watch vessels to observe Mexican sanctuary regulations; and encourage protective measures and further research in Canada and Russia, also within the home range of the eastern North Pacific population of gray whale.

4) Continue participation in the International Whaling Commission's (IWC) Scientific Committee meetings, in order to (among other things), coordinate research on gray whales by member nations.

A GOALS AND OBJECTIVES

Although recognizing current budgetary restraints, the goal of the monitoring plan is to document and evaluate the significance of any changes in the status and viability of this stock for a minimum of five years following delisting. The objectives of the monitoring plan are to:

(1 Monitor the status of the gray whale and habitats essential to its survival.

(2) Continue monitoring the level and frequency of gray whale mortality through small take and commercial fishery exemptions, stranding programs and other activities.

(3) Evaluate the results of status determinations for gray whales based on recently developed assessment techniques.

(4) Continue monitoring, through participation in the IWC Scientific Committee, the magnitude and composition of the subsistence harvest of gray whales by Russians.

(5) Monitor the concentrations of chemical contaminants in gray whales, including organochlorines (e.g., PCBs, chlorinated pesticides) and heavy metals.

A. STEPDOWN OUTLINEpa

Priorities under this plan are identified in Appendix B.

(1) Monitor the status of the gray whale and habitats essential to its survival.

(1.1) Conduct a biennial population survey to include:

(1.11) A survey of the southbound migration for comparison with historical data in the winters of 1993/1994, 1995/1996, and 1997/1998.

(1.12) Carry out research as needed to determine any potential biases in the estimation of procedures (e.g., offshore distribution, tails of the migration, night-time migration rates).

1.2) Estimate population productivity using:

(1.21) Data obtained from life history studies, as may be appropriate, such as proportion of mature females that are pregnant taken in subsistence hunts.

1.22) Data obtained from survey of northbound migration in the spring of 1994 for comparison with cow-calf counts from the early 1980s and the pregnancy data from the Soviet aboriginal harvest.

(1.3) Conduct research as needed to determine the dependence of the population on specific areas for feeding and breeding.

(1.31) Determine the importance to breeding success of optimum' habitat within the calving lagoons along the west coast of Baja California, Mexico.

(1.32) Determine the status of benthic amphipod standing stock within the population's summer feeding range in the Bering and Chukchi Seas.

(2) <u>Continue monitoring the level and frequency of gray whale mortality through small take and commercial fishery exemptions, stranding programs and other activities</u>.

(2.1) Monitor the annual number of strandings by age and sex classes along the west coast and Alaska through the existing stranding networks.

(2.2) Estimate the number of animals incidentally killed by age and sex classes by fisheries in California, Oregon, Washington, and Alaska.

(2.3) Monitor the number of animals legally killed and taken under small take exemption authority of the MMPA.

(3) <u>Evaluate the results of status determinations for gray whales based on recently developed assessment techniques</u>.

(3.1) Complete the report that presents information on abundance and trends in abundance, based on data that includes estimates from the southbound migration in the winter of 1992/1993.

(3.2) Complete the report on status that includes:

(3.21) Historical estimates of abundance based on standard back-calculation models.

(3.22) A Bayesian-synthesis approach to evaluating the status of the eastern stock of North Pacific gray whales.

(4) Continue monitoring, through participation in the IWC Scientific Committee, the magnitude and composition of the subsistence harvest of gray whales by Russians.

(4.1 Continue participation in IWC Scientific Committee, the SC's subcommittee on Protected Stocks, and reviews by the SC on the status of gray whales.

(4.2) Continue cooperative research with the Russians concerning seasonal and geographic factors thatmay have biased the apparent downward trend in pregnancy rates of animals taken for subsistence purposes.

(5) Monitor the levels of contaminants in gray whales, including organochlorines (e.g., PCBs, chlorinated pesticides) and heavy metals.

(5.1) Collect tissue samples from stranded animals along the west coast and from the Russian subsistence harvest and analyze for contaminant levels.

(5.2) Refine the methods for collecting biopsies from free ranging animals during the northbound and southbound migrations and analyze tissues collected for contaminant levels.

C. NARRATIVE

1) Monitor the status of the gray whale and habitats essential to its survival.

(1.1) Conduct a biennial population survey to include:

(1.11) A survey of the southbound migration for comparison with historical data in the winters of 1993/1994, 1995/1996, and 1997/1998 to assess trends and the level of recovery.

The National Marine Mammal Laboratory will conduct a shore-based survey of the southbound migration of gray whales 10 December to 7 February in 1993/94, 1995/96 and 1997/98 from Granite Canyon Marine Laboratory, 13 km south of Carmel, California. Rugh et al. (in press) describe the survey protocol and the observation site in detail. Granite Canyon has been used for previous surveys since 1975 (Reilly et al. 1983, Breiwick et al. 1988). As gray whales pass Granite Canyon, they are counted by 2 independent observers from a team of observers*papapa* that rotate through 3 watch periods (0700-1030 hr, 1030-1330 hr, and 1330-1700) of each day during the survey period. Whale counts are the core of the survey; however, not all of the passing whales are counted, and between-year variations in total counts do not necessarily reflect changes in the population size.

These deficiencies are addressed by constructing an estimate of the population size which is based on several correction factors (Buckland et al. 1993a). The correction factors account for: 1) whales which pass during the non-watch periods at night and periods of the day, when weather conditions are not suitable for observing whales, 2) whale pods missed during the watch periods, and 3) bias in the estimates of pod size. Each correction factor may vary between surveys because of changes in visibility conditions, sea state, observer ability, etc. When possible, observers will collect relevant data during each survey to estimate each correction factor.

The proportion of whales which pass during non-watch periods is estimated by fitting a Hermite-polynomial model to the counts through time (Buckland et al. 1993a). The area under the curve during non-watch periods provides an estimate of the proportion of whales missed. Without adjustment, it is assumed that whales pass at the same rate during the night as in the day. Radio-tagging experiments with gray whales monitored both day and night (Swartz et al. 1987) demonstrated a slightly greater speed at night (Buckland et al. 1993a). However, the data used for the correction factor for night passage are limited and further investigation is warranted.

Simultaneous independent counts by 2 observers provide the basis for estimating the proportion of whale pods missed within the observers field of view (approximately within 3 nm of the coast). Sightings from each observer are considered to be the same whale pod if the observation times, distance offshore and pod size estimates are within preset limits, as defined by a matching algorithm (Rugh et al. in press). The probability of detecting a whale is modelled with logistic regression using the matched data (Buckland et al. 1993a).

Observers may also miss sightings if whales travel too far offshore. Aerial surveys will be flown perpendicular to the coast as described by Withrow et al. (1993) during the peak 2-3 weeks of the migration. The proportion of whales observed beyond 3 nm will be used to correct the shore-based counts.

During the peak of the migration, while the aircraft is available, simultaneous estimates of the size of selected pods will be made from the air and shore. The average difference between shore observer estimates and the aerial estimate (considered the "true" group size) will be used as an estimate of shore observer bias and will be used to correct the observed average pod size from the shore-based count (Reilly et al. 1983).

(1.12) Carry out research as needed to determine any potential biases in the estimation of procedures (e.g., offshore distribution, tails of the migration, night-time migration rates).

Research will be conducted to investigate potential sources of bias in the current survey methodology and to improve estimation of the correction factors. Currently identified research areas are outlined below.

Night vs. day rate of passage: Experiments with a thermal sensor, which allows an observer to detect whale blows at night and day, will be conducted to improve measurement of passage rates of whales during evening and daylight hours. The thermal sensor will operate for 3-hour sampling periods during the day and night for 21-28 days during the migration peak. The projected level of sampling should roughly achieve a 10% coefficient of variation (CV) for the correction factor. Sources of bias from potential changes in offshore distribution and respiration rate at night will be investigated.

Double-count: The sensitivity of the double-count correction factor to changes in the parameters used in the matching algorithm needs to be studied. The current variance estimate does not include uncertainty in matches and the true variance is likely much larger than the estimated variance. The logistic regression model contains passage rate and distance offshore as covariates that increase the probability of detecting a whale pod (Buckland et al. 1993a). This may indicate that the algorithm is more likely to find a match when the distance between whale pods decreases. Further research is needed on the development of a matching algorithm.

Offshore distribution: The aerial survey provides an empirical estimate of the distribution of the offshore distance that whales are travelling. It is possible to use this empirical distribution as a prior distribution to construct an estimator of the probability of missing a whale pod using distance sampling (Buckland et al 1993b). In the planned aerial surveys, tracklines will be centered closer to Granite Canyon and GPS will be used to obtain more accurate distance measurements than have previously been available. With this alternative estimation scheme, double-count data will be used to estimate the probability a whale is missed close to shore (<0.75 nm). Matches between observers are more certain for whales within 0.75 nm because they occur less frequently.

(1.2) Estimate population productivity using:

(1.21) Data obtained from life history studies, as may be appropriate, such as proportion of mature females that are pregnant taken in subsistence hunts.

A research project has been initiated to reanalyze the past pregnancy rate data in light of the area and month in which the animals were captured, to determine if the apparent inter-annual decline is real, or an artifact of sampling (see section 4.2). This project is being conducted jointly between SWFS Scientists and Russian scientists closely familiar with the data. These data will be supplemented with information on the length frequency distribution of animals during the northbound migration, using photogrammetric techniques (see section 1.22).

(1.22) <u>Data obtained from survey of northbound migration in the spring of 1994 for comparison with cow-calf counts from the early 1980s and the pregnancy data from the Russian subsistence harvest</u>.

The Southwest Fisheries Science Center will conduct a shore-based visual survey of north migrating cows and calves, from 15 March to May 31, 1994. The study essentially will replicate the 1980 and 1981 surveys conducted by Poole (1984a). It will be conducted from Pt. Piedras Blancas, on the central California coast. Pairs of observers will count northbound cows and calves as they pass the point during daylight hours. In addition to the visual survey, two verification projects will be conducted. First, a thermal sensor will be used on a sampling basis during day and night hours to test the hypothesis that whales pass at night at the same rate as during the day. This is important because the largest extrapolation from observed whales to total is for those passing unseen at night. Second, an aerial survey will be conducted to determine what portion (if any) of passing cow and calf pairs are too far from land to be seen. Poole conducted aerial surveys to verify his ground counts, but the thermal sensor work will be new. Results of this field program will include an estimate of newborn calves surviving to pass Pt Piedras Blancas. This number will be compared to equivalent estimates from 1980 and 1981 to test for a decline in calf production.

(1.3) Conduct research as needed to determine the dependence of the population on specific areas for feeding and breeding.

(1.31) <u>Determine the importance to breeding success of optimum' habitat within the calving lagoons along the west coast of Baja California, Mexico</u>.

While it may never be possible to definitively determine the degree of dependence of gray whales on the coastal lagoons of Baja California, recent sightings of newborn calves during the southward fall migration from central California to the U.S.-Mexican border raise question as to necessity of the coastal lagoons as calving and calf-rearing areas for gray whales. It would appear that the lagoons may be preferred habitats for females with calves, but the benefits to calf survival would need to be assessed both inside and outside the lagoon systems. It is assumed that the protected lagoon waters, their lack of predators, and high concentrations of female-calf whales within the lagoons are advantageous to calf survival during the first few months of the calves' lives. One approach to testing this assumption would be to compare calf mortality within lagoon habitats to that outside the lagoon areas along the migration route. For example, one could compare, by radio-tagging the mothers, the survivorship of calves born during migration with those born or newly-born within any of the lagoon systems in Baja

California. Looking at calf stranding rates or surveys of calf abundance are too fraught with bias and error to allow valid comparisons.

(1.32) Determine the status of benthic amphipod standing stock within the population's summer feeding range in the Bering and Chukchi Seas.

Preliminary information available at the 1990 IWC Comprehensive Assessment of gray whales indicated that the prey resource for gray whales was showing signs of over utilization. This preliminary observation should be followed up with a comprehensive status assessment. This may have been done, or be in progress. The task group should contact benthic ecologists specializing in this topic at the University of Alaska to determine the availability of this information, and if action is required on the part of NMFS.

(2) Continue monitoring the level and frequency of gray whale mortality through small take and commercial fishery exemptions, stranding programs and other activities.

(2.1) Monitor the annual number of strandings by age and sex classes along the west coast and Alaska through the existing stranding networks.

Through the regional stranding network coordinator, NMFS' Office of Protected Resources is the recipient of reports from the regional stranding networks throughout the United States. Once implemented, the gray whale research and monitoring plan will recommend that NMFS regularly solicit and review stranding records for gray whales in those regions in which they occur, and identify any unusual changes in the regional stranding rates.

(2.2) Estimate the number of animals incidentally killed by age and sex classes by fisheries in California, Oregon, Washington, and Alaska.

Amendments to the Marine Mammal Protection Act require that incidental takes of marine mammals, including gray whales, be reported to the NMFS by fishermen and other individuals that incidentally "take" them. These records are compiled and reviewed by the NMFS' Office of Protected Resources, and any trends in the rate of takes by specific vessels, fisheries, or other sources are assessed and mitigation actions recommended.

(2.3) Monitor the number of animals legally killed and taken under small take exemption authority of the MMPA.

All marine mammals taken under Section 101 (a)(5) of the Marine Mammal Protection Act must be reported to the NMFS as a condition of the exemption process so that the Secretary of Commerce can determine whether the taking is "negligible" and will not have an "unmitigable adverse impact" on the availability of the affected species or stock for subsistence uses. As part of this research/monitoring plan, NMFS' Office of Protected Resources will monitor, assess, and report the number, age and sex composition of all gray whales taken under Section 101 (a)(5) of the MMPA.

(3) Evaluate the results of status determinations for gray whales based on recently developed assessment techniques.

(3.1) Complete the report that presents information on abundance and trends in abundance, based on data that includes estimates from the southbound migration in the winter of 1992/1993.

The estimated annual rate of increase of the eastern Pacific gray whale population is 3.3% (CV=0.4%) over the period 1967/68 - 1987/88 (Buckland and Breiwick in press) and the current population estimate is 20,869 (CV=4.4%), based on the 1987/88 shore count data (Buckland et al. 1993a). The most recent shore count of the southbound migration was made December 1992 - January 1993 and these data will be analyzed to provide an abundance estimate for 1992/93 as well as an updated annual rate of increase.

(3.2) Complete the report on status that includes:

(3.21) Historical estimates of abundance based on standard back-calculation models.

Several researchers (Reilly 1981; Lankester and Beddington 1986; Cooke 1986; Butterworth et al. in press) have demonstrated that gray whale population trajectories which pass through a current population estimate and utilize the available historic commercial catch data are inconsistent with the commercial extinction of the stock at the end of the 19th century and with the observed rate of increase of the stock. Cooke (1986) employed a simple back-calculation model using a range of current population sizes and net recruitment rates and demonstrated the problem that others have encountered: all combinations of parameters imply an 1846 population level lower than the current level. Cooke suggested four possible explanations for these results: i) historical catches were underestimated; ii) the recent net recruitment rate or population size has been overestimated; iii) the population was already at a low level prior to 1846; or iv) the recent population increase is not a result of a simple density dependent recovery from previous exploitation.

An extensive review of aboriginal whaling for gray whales of the east Pacific stock by Mitchell and Reeves (in press) suggest that the early aboriginal kill may have been on the order of 100% more than documented. This alone, however, does not resolve the above mentioned inconsistency. Butterworth et al. (1990) determined that a model which incorporates an additional response delay in recovery from exploitation produced unrealistic population oscillations. Consistent results can be obtained if any of the following adjustments are made: 1) the carrying capacity is allowed to increase by a factor of 3 from 1846 to 1988, or 2) the historic commercial catch from 1846 to 1900 is increased by a factor of 1.5 and the annual aboriginal catch prior to the commercial fishery is at least 400.

Results appear to be relatively insensitive to values assumed for the biological parameters of the population model (natural mortality rate, age at first parturition, age at recruitment and MSY level) but sensitive to assumptions about data inputs (current population size accuracy and male:female sex ratio assumed for catches).

(3.22) A Bayesian synthesis approach to evaluating the status of the eastern stock of North Pacific gray whales.

Raftery et al. (1992) have developed a Bayesian synthesis approach for making inferences from a deterministic population model with many inputs and outputs. Their approach consists of defining a joint prior, or, in their terminology, a pre-model distribution, on the model inputs and outputs for which there is evidence independent of the model. By sampling from the pre-model distribution and using the population dynamics model, a post-model distribution for the parameters is obtained from which inferences can be drawn. They employ the SIR (sampling importance resampling) algorithm to evaluate the posterior (post-model) distribution. Some of the benefits of Bayesian synthesis methodology are 1) reduction in variance of model parameters, 2) joint and marginal probability density functions for all model inputs and outputs are provided, 3) contributions to variance by each factor can be estimated, and 4) new questions of interest can be formulated and answered after the primary analysis is complete. The Bayesian synthesis method is currently set up for bowhead whales and is programmed in the S language. Givens and Punt (pers. comm.) are rewriting the S code in FORTRAN and this should be available in January 1994. Using the available historical catch series and our knowledge of gray whale biological parameters, the Bayesian synthesis program developed for bowhead whales can be modified for use with gray whales.

(4) Continue monitoring, through participation in the IWC Scientific Committee, the magnitude and composition of the subsistence harvest of gray whales by Russians.

(4.1) Continue participation in IWC Scientific Committee, the SC's subcommittee on Protected Stocks, and reviews by the SC on the status of gray whales.

The IWC Scientific Committee periodically reviews the status of whale stocks subject to exploitation, including gray whales, in order to provide advice to the Commission on allowable aboriginal catch limits. For gray whales this was last done in 1991 and is scheduled to occur again in May, 1994. It is very important for US scientists to take an active role in this process. It is also beneficial to the US to have this international forum for gray whale status determinations.

(4.2) <u>Continue cooperative research with the Russians concerning seasonal and geographic factors that may have biased the apparent downward trend in pregnancy rates of animals taken for subsistence purposes</u>.

A preliminary analysis of published pregnancy rates from the Soviet (now Russian) aboriginal fishery for gray whales indicated an apparent downward trend, at least during the 1980s (Reilly 1992). However, Blokhin (1989) presented a summary showing marked differences in pregnancy rates by subarea within thepa fishery zone around the Chukchi Peninsula, and steep declines in rates by month from almost 60% in July to 12% in November. A research project has been initiated to reanalyze the past pregnancy rate data in light of the area and month in which the animals were captured, to determine if the apparent inter-annual decline is real, or an artifact of sampling. This project is being conducted jointly between SWFS Scientists and Russian scientists closely familiar with the data. The analyses may point to the need for additional research, including collection and analysis of data from future subsistence fishery takes.

(5) Monitor the levels of contaminants in gray whales, including organochlorines (e.g., PCBs, chlorinated pesticides) and heavy metals.

(5.1) <u>Collect tissue samples from stranded animals along the west coast and from the Russian subsistence harvest and analyze for contaminant levels</u>.

Tissue samples from stranded gray whales will be analyzed for toxic chemical contaminants to assess the distribution of contaminants among potential target tissues, to begin to assess trends in contaminant levels, and in the case of concentrations of chlorinated hydrocarbons in blubber for comparison to concentrations in apparently healthy free ranging whales. In sampling stranded animals, tissues will be collected primarily from animals that have been dead less than 24 hours. In addition, acquisition of samples of blubber and internal organs from gray whales from the Russian subsistence harvest will be pursued for additional comparison with samples from stranded animals. The tissue samples will be held on ice and then frozen as soon as possible after collection. The samples will be stored at -80°C until analyzed. In addition, tissue samples will be made available to laboratories interested in determining the genetic diversity between the two extant stocks of gray whales in the Pacific.

The concentrations of selected chlorinated hydrocarbons (e.g., PCBs, planar PCB congeners and chlorinated pesticides such as DDTs, chlordanes and toxaphenes) and certain essential (e.g., zinc, selenium, copper) and toxic (e.g., mercury, lead) elements in liver, kidney, and if available, brain and stomach contents, and chlorinated hydrocarbons in blubber will be determined. The concentrations of chlorinated hydrocarbons and trace elements will be determined according to Sloan et al. (1993) and Robisch and Clark (1993), respectively. Because gray whales feed on benthic organisms and therefore may be exposed to contaminants present in contaminated sediments, the inclusion of stomach contents for analysis is important in assessing diet as a route of exposure. In addition, selected samples of stomach contents will be analyzed for aromatic hydrocarbons to estimate potential exposure to this class of chemical contaminants. The efficient metabolism of aromatic hydrocarbons by vertebrates limits substantially the accumulation of aromatic hydrocarbons in tissues. Gray whales can potentially be exposed to aromatic hydrocarbons through ingestion of sediment that may be contaminated and through their primary prey of benthic invertebrates, primarily crustaceans. Some crustaceans have a less developed ability for metabolism of aromatic hydrocarbons and can accumulate parent aromatic hydrocarbons.

Biological data (e.g., sex, length, girth, blubber thickness, reproductive status) including behavioral observations, necropsy results, and abnormalities found, will be collected from each animal sampled.

(5.2) Refine the method for collecting biopsies from free ranging animals during the northbound and southbound migrations and analyze tissues collected for contaminant levels.

The collection of biopsy samples from free ranging gray whales is still in the developmental stage. Previous studies with blue and humpback whales showed that small portions of blubber were collected along with dart samples of skin that were collected for genetic studies. Moreover, recent studies using a pneumatic device to propel the dart was successful in collecting blubber biopsy samples from cetaceans of sufficient size for chemical analyses (C. Fossi, pers. commun.). Initial sampling efforts to collect blubber biopsy samples from northbound gray whales using a dart were not fully successful, however, and revealed several difficulties in obtaining blubber samples (J. Calambokidis, pers. commun.). For example, skin samples were only recovered from a small number of dart samples and the only blubber sample recovered was very small; probably too small for chemical analysis. The continuation of developmental studies is needed to optimize the dart method for collecting biopsy samples from gray whales including the need to sample southbound whales.

Analysis of data obtained from a preliminary study (Varanasi et al. 1993) reporting concentrations of contaminants in samples from 22 whales that stranded in previous years (1988-1991) showed that samples from 75-160 whales are needed to be 95% confident that the mean concentrations of contaminants measured in blubber will be within 20 to 30% of the population mean values for gray whales. The estimate of the number of biopsy samples needed to determine the population mean for chlorinated hydrocarbons was made from the variance for concentrations in stranded animals. TopXinsurthat the estimated number of samples needed is accurate for free ranging animals, approximately 20-30 whales will be initially sampled and analyzed to confirm the optimum number of animals to sample to accurately estimate the mean concentration values for the entire population of free ranging gray whales. The biopsy samples collected will be held on ice and then frozen as soon as possible after collection. The samples will be stored at -80°C until analyzed. The skin will be retained for possible genetic analyses and the blubber analyzed for chlorinated hydrocarbons as described in section 5.1.

Part III. **REFERENCES**

Albert, T.F. (ed). 1981. Tissue structural studies and other investigations on the biology of endangered whales in the Beaufort Sea. Rept. to Bureau Land Mangt. from the Dept. Vet. Sci., Univ. of Maryland, College Park, MD. 953 pp.

Baird, R.W., P.J. Stacey, D.A. Duffus and K.M. Langelier. In press (1990). An evaluation of gray whale (Eschrichtius robustus) mortality incidental to fishing operations in British Columbia. In, Braham, H.W. and G.P. Donovan (eds), A Comprehensive Assessment of the Gray Whale. International Whaling Commission (Special issue 14), Cambridge, U.K.

Berzin, A.A. 1984. Soviet studies of the distribution and numbers of the gray whale in the Bering and Chukchi Seas, from 1968 to 1982. pp. 409-419. In, Jones, M.L., S.L. Swartz, and J.S. Leatherwood (eds.). The Gray Whale Eschrichtius robustus. Academic Press, Inc., New York.

Berzin, A.A. In press. Gray whales of the Okhotsk-Korean population in the Sea of Okhotsk. In, Braham, H.W. and G.P. Donovan (eds), A Comprehensive Assessment of the Gray Whale. International Whaling Commission (Special Issue 14), Cambridge, U.K.

Blokhin, S.A., M.K. Maminov and G.M. Kosygin. 1985. On the Korean-Okhotsk population of gray whales. Rept. int. Whaling Commn 35: 375-376.

Blokhin, S.A. 1989. A note on the spatial distribution of gray whales off Chukotka. Rept. int. Whaling Commn 39:309-311.

Braham, H.W. 1984. Distribution and migration of gray whales in Alaska. pp 249-267. In, Jones, M.L., S.L. Swartz, and J.S. Leatherwood (eds.). The Gray Whale Eschrichtius robustus. Academic Press, Inc., New York.

Braham, H.W. and G.P. Donovan (eds). In press. A Comprehensive Assessment of the Gray Whale. International Whaling Commission (Special Issue 14), Cambridge, U.K.

Braithwaite, L.F., M.G. Aley, and D.L. Slater. 1983. The effects of oil on the feeding mechanism of the bowhead whale. Final Rept. prepared for U.S. Dept Interior under contract no. AA851LT055. June 10, 1983. 45 pp.

Bratton, G.R., C.B. Spainhour, W. Flory, M. Reed, and K. Jayko. 1993. Presence and potential effects of contaminants. Pp. 701-744. In, Burns, J.J., J.J. Montague, and C.J. Cowles (eds), The Bowhead Whale. Society of Marine Mammalogy, Lawrence, KS.

Breiwick, J.M. and H.W. Braham (eds). 1984. The Status of Endangered Whales. Mar. Fish. Rev. 46(4): 1-64.

Breiwick, J., Rugh, D., Withrow, D., Dahlheim, M. and Buckland, S. 1988. Preliminary population estimate of gray whales during the 1987-88 southward migration. Document SC/40/PS12 submitted to the Scientifi Committee of the International Whaling Commission, June 1988, 21pp.

Breiwick, J.M., D.J. Rugh, D.E. Withrow, M.E. Dahlheim, and S.T. Buckland. 1989. Preliminary population estimate of gray whales during the 1987/88 southward migration. Rep. int. Whaling Commn 39: 465.

Brownell, R.L. 1971. Whales, dolphins and oil pollution. In, Straughan, D. (ed). Biological and Oceanographic Survey of the Santa Barbara Channel Oil Spill 1969-1970. Sea Grant Publ. No. 2. vol 1, pp. 255-276. Allan Hancock Found. Univ. South. Calif. Los Angeles CA.

Brownell, R.L. Jr. and C. Chun. 1977. Possible existence of the Korean stock of the gray whale (Eschrichtius robustus). J. Mamm. 58(2): 237-238.

Brownell, R.L. Jr. and T. O'Shea. In press. Review of organochlorine pollutants and heavy metals in baleen whales. In, Braham, H.W. and G.P. Donovan (eds), A Comprehensive Assessment of the Gray Whale. International Whaling Commission (Special Issue 14), Cambridge, U.K.

Bryant, P.J. and C.M. Lafferty. 1980. The gray whale of Guerrero Negro. The Whalewatcher 14(4):3-5.

Bryant, P.J., C.M. Lafferty, and S.K. Lafferty. 1984. Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by gray whales. Pp. 375-387. In, Jones, M.L., S.L. Swartz, and J.S. Leatherwood (eds.). The Gray Whale Eschrichtius robustus. Academic Press, Inc., NY.

Buckland, S.T., Breiwick, J.M., Cattanach, K.L., and Laake, J.L. 1993a. Estimated population size of the California gray whale. Mar. Mamm. Sci. 9(3):235-249.

Buckland, S.T., Anderson, D.R., Burnham, K.P., and Laake, J.L. 1993b. Distance Sampling: estimating abundance of biological populations. Chapman & Hall, London. 446pp.

Buckland, S.T. and J.M. Breiwick. In press. Estimated trends in abundance of California gray whales from shore counts, 1967/68 to 1987/88. In, Braham, H.W. and G.P. Donovan (eds), A Comprehensive Assessment of the Gray Whale International Whaling Commission (Special Issue 14), Cambridge U.K.

Butterworth, D.S., J.L. Korrubel and A.E. Punt. In press. What is needed to make a simple density-dependent response population model consistent with data for the eastern North Pacific gray whales? In, Braham, H.W. and G.P. Donovan (eds), A Comprehensive Assessment of the Gray Whale. International Whaling Commission (Special Issue 14), Cambridge, U.K.

Bursk, M. 1988. Response of whales to whale watching in Southern California. p 11. In, CMC/NMFS. 1988. Proceedings of the Workshop to Review and Evaluate Whale Watching Programs and Management Needs. November 14-16, 1988. Monterey California.

Center for Marine Conservation/National Marine Fisheries Service. 1988. Proceedings of the Workshop to Review and Evaluate Whale Watching Programs and Management Needs. November 14-16, 1988. Monterey, California. 53pp.

Collins, R. A., M. M. Vojkovich, A. R. Hartmann, and R. J. Reed. 1984. Progress report: Southern California nearshore gill and trammel net study, 1983. California Department of Fish and Game, Marine Resources Branch, Long Beach, California 90813. 33 pp.

Collins, R. A., M. M. Vojkovich, and R. J. Reed. 1985. Progress report: Southern California nearshore gill and trammel net study, 1984. California Department of Fish and Game, Marine Resources Branch, Long Beach, California 90813. 40 pp.

Collins, R. A., M. M. Vojkovich, R. J. Reed, and K. A. Heib. 1986. Progress report: Southern California nearshore gill and trammel net study, 1985. California Department of Fish and Game, Marine Resources Branch, Long Beach, California 90813. 50 pp.

Cooke, J.G. 1986. On the net recruitment rate of gray whales with reference to inter-specific comparisons. Rep. int. Whal. Commn 36:363-366.

Cordoba, F. 1981. La ballena gris y la explotacion de fosfora en Baja California Sur (The gray whale and the exploitation of phosphorus in southern Baja California). In, Ballena Gris. Centro de Estudios Economicos y Sociales del Tercer Mundo, Mexico. [In Spanish].

Dahlheim, M.E. 1983. Acoustical studies on the gray whale (<u>Eschrichtius robustus</u>) in Laguna San Ignacio, Baja California Sur, Mexico. Final Report to the Department of Pesca, Mexico City, Mexico. Section II Permit No. 242.2-00227-140. September 1983, 52 pp.

Dahlheim, M.E. 1984. Acoustical studies of the gray whale (Eschrichtius robustus) in Laguna San Ignacio, Baja California Sur, Mexico. Final report to the Department of Pesca, Mexico City, Mexico. Permit No. 1512823304498. December, 1984. 51 pp.

Dahlheim, M.E. 1988a. Responses of gray whales to increased noise levels in Mexico. p. 14. In, Center for Marine Conservation and National Marine Fisheries Service. 1988. Proceedings of the Workshop to Review and Evaluate Whale Watching Programs and Management Needs, 14-16 November 1988, Monterey CA.

Dahlheim, M.E. 1988b. Bio-acoustics of the gray whale. Ph.D. dissertation University of British Columbia, Canada.

Dahlheim, M.E., H.D. Fisher, and J. Schempp. 1984. Sound production by (Eschrichtius robustus) and ambient noise levels in Laguna San Ignacio, Baja California Sur, Mexico, p. 499-529. In, Jones, M.L., S.L. Swartz, and J.S. Leatherwood (eds.), The Gray Whale Eschrichtius robustus. Academic Press, Inc., New York.

Dahlheim, M.E. and D.K. Ljungblad. 1990. Preliminary hearing study on gray whales in the field, p. 335-346. In, Thomas, J. and R. Kastelein (eds), Sensory Abilities of Cetaceans. Plenum Press, New York.

Di Toro, D.M., C.S. Zarba, D.J. Hansen, W.J. Berry, R.C. Swartz, C.E. Cowan, S.P. Pavlou, H.E. Allen, N.A. Thomnas, and P.R. Paquin. 1991. Technical basis for establishing sediment quality criteria for nonionic organic chemicals using equilibrium partitioning. Environ. Toxicol. Chem. 10:1541-1583.

Evans, W.E. 1982. A study to determine if gray whales detect oil. In, Geraci, J.R. and D.J. St. Aubin. (eds), Study of the Effects of Oil on Cetaceans. Final Rep., Contract No. AA551-CT9-29, p. 47-61. BLM. Washington DC.

Fay, F.H., R.A. Dieterich, L.M. Shults, and B.P. Kelly. 1978. Morbidity and mortality of marine mammals. In, Environmental Assessment of the Alaskan Continental Shelf. Annual Rept. 1: 39-79. U.S.Dept. Comm. Nat. Oceanic Atmos. Admin., Environ. Res. Lab., Boulder, CO.

Gard, R. 1974. Aerial census of gray whales in Baja lagoons, 1970 and 1973, with notes on behavior, mortality and conservation. Cal. Fish Game 60:132-143.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans, p. 167-197 In, Geraci, Joseph R. and David J. St. Aubin (eds), Sea Mammals and Oil: Confronting the Risks. Academic Press, San Diego.

Geraci, J.R. and D.J. St. Aubin. 1980. Offshore petroleum resource development and marine mammals: a review and research recommendations. Mar. Fish. Rev. Nov. 1980. p.1-12.

Geraci, J.R. and D.J. St. Aubin. 1982. Study of the effects of oil on cetaceans Final Report. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C. Contract TAA SSI-CT9-29. 274 p.

Geraci, J.R. and D.J. St. Aubin. 1985. Expanded studies of the effects of oil on cetaceans. Final Report. Part I. U.S. Department of the Interior, Minerals Management Service, Washington, D.C. Contract No. 1412-0001-29169. 144 p

Geraci, J.R. and D.J. St. Aubin. 1990. Summary and conclusions, p 253-256. In, Geraci, Joseph R. and David J. St. Aubin (eds), Sea Mammals and Oil: Confronting the Risks. Academic Press. San Diego, CA. 282 p.

Gilmore, R.M. 1960. A census of the California gray whale U.S. Fish and Wildlife Service, Spec. Sci. Rep.-Fish. 342, 30 p.

Gilmore, R.M., R.L. Brownell, J.G. Mills, and A. Harrison. 1967. Gray whales near Yavaros, southern Sonora, Golfo de California, Mexico. Trans. San Diego Soc. Nat. Hist. 14(16):197-204.

Graham, W.C. 1989. Southbound migrations of the gray whale near San Clemente Island in the Southern California Bight - 1986 to 1989. Abstr. Eighth Biennial Cong. on the Biology of Marine Mammals. Pacific Grove, CA, December 7-11, 1989.

Henderson, D.A. 1972. Men and Whales at Scammon's Lagoon. Dawson's Book Shop, Los Angeles, CA

Henderson, D.A. 1984. Nineteenth century gray whaling: grounds, catches, and kills, practices and depletion of the whale population, p. 159-186. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale _Eschrichtius robustus_. Academic Press, New York.

Heyning, J.E. and M.E. Dahlheim. In press. Strandings and incidental takes of gray whales. In, Braham, H.W. and G.P. Donovan (eds), A Comprehensive Assessment of the Gray Whale. International Whaling Commission (Special issue 14), Cambridge, U.K.

Heyning, J.E. and T.D. Lewis. 1990. Entanglements of baleen whales in fishing gear off Southern California. Rep. int. Whal. Commn 40:427-431.

Ivashin, M. 1990. Gray whale harvesting by Chukotkan aboriginal population. Unpublished manuscript. Presented at the Special Meeting of the Scientific Committee of the IWC on the Assessment of Gray Whales. April 23-27, 1990, Seattle, Washington. 29 p.

International Whaling Commission. 1990. Report of the Special Meeting of the Scientific Committee on the Assessment of Gray Whales. April 23-27, 1990, Seattle, Washington. Unpubl., 29 p.

International Whaling Commission. 1992 Report of the International Whaling Commission. Cambridge, U.K. 776 p.

Jones, M.L., and S.L. Swartz. 1984. Demography and phenology of gray whales and evaluation of whale-watching activities in Laguna San Ignacio, Baja California, Sur, Mexico, p. 309-374. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Jones, M.L. and S.L. Swartz. 1987. Radio-telemetric study and aerial census of gray whales in the Channel Islands National Marine Sanctuary during the southward migration, January 1986. Final Rept. prepared for NMML/NWAFC/NMFS/NOAA. Contract No. 50-ABNF-6-00067.

Jones, M.L. and S.L. Swartz. 1989. Gray whale (Eschrichtius robustus) abundance and distribution in the Channel Islands National Marine Sanctuary during the southward migration: January 1986 and 1987. Abstract Eighth Biennial Conf. on the Biology of Marine Mammals, Pacific Grove, CA December 7-11, 1989.

Jones, M.L., S.L. Swartz, and M.E. Dahlheim. 1991. Census of gray whales in San Ignacio Lagoon in 1985: a follow-up study in response to low whale counts in 1984. Final Report to the Marine Mammal Commission for Contract No. MM2911023-0. Available through NTIS.

Klinowska, M. 1991. Dolphins, Porpoises and Whales of the World. The IUCN Red Data Book. IUCN. Gland Switzerland.

Landrum, P.F., and J.A. Robbins. 1990. Biavailability of sediment-associated contaminants to benthic invertebrates, p. 237-263. In, Baudo, R., J.P. Giesy, and H. Muntau (eds), Sediments: Cemisty and Toxicity of In-OPlace Pollutants. Lewis Publishers, Inc., Ann Arbor, MI.

Lankester, K. and J.R. Beddington. 1986. An age structured population model applied to the gray whale (Eschrichtius robustus). Rep. int. Whal. Commn 36:353-358.

Loughlin, T.R. In press. Tissue hydrocarbon levels and number of cetaceans found dead after the spill. In, Loughlin, T.R. (ed), The Impact of the Exxon Valdez oil spill on Marine Mammals. Academic Press, New York.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Report No. 5366, Bolt Beranek and Newman, Inc., November 1983.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Phase II: January 1984 migration. Report No. 5586, Bolt Beranek and Newman, Inc. August, 1984.

Marquette, W.M. and H.W. Braham. 1992. Gray whale distribution and catch by Alaskan Eskimos: a replacement for the bowhead whale? Arctic 35(3):386-394.

Mead, J.G. and E.D. Mitchell. 1984. Atlantic gray whales, p. 33-51. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Minerals Management Service. 1991. Outer Continental Shelf Natural Gas and Oil Resource Management. Comprehensive Program, 1991 - 1997. Draft Proposal. U.S. Dept. Interior. 3 vols.

Minerals Management Service. 1992. Outer Continental Shelf Natural Gas and Oil Resource Management. Comprehensive Program, 1991 - 1997. Final Environmental Impact Statement. U.S. Dept. Interior. April 1992. 4 vols.

Mitchell, E.D. and R.R. Reeves. In press. Aboriginal whaling for gray whales of the east Pacific stock. In, Braham, H.W. and G.P. Donovan (eds). A Comprehensive Assessment of the Gray Whales. International Whaling Commission (Special Issue 14), Cambridge, U.K.

National Marine Fisheries Service. 1990. Status report on contaminants in gray whales from Washington State. November 5, 1990 memorandum form R. Berry to R. Schmitten. 4 pages, tables.

National Marine Fisheries Service. 1991. Proposed Regime to Govern Interactions Between Marine Mammals and Commercial Fishing Operations. Draft Legislative Environmental Impact Statement. June 1991.

National Research Council. 1985. Oil in the Sea. Inputs, fates and effects. National Academy Press, Washingotn D.C.

Neff, J. 1987. Biological effects of drilling fluids, drill cuttings and produced waters, p. 469-538. In, Beosch, D.F. and N.N. Rabalais (eds). Long-Term Environmental Effects of Offshore Oil and Gas Development. Elsevier Applied Science. New York.

Neff, J. 1990a. Composition and fate of petroleum and spill-treating agents in the marine environment, p. 1-33. In, Geraci, Joseph R. and David J. St. Aubin (eds). Sea Mammals and Oil: Confronting the Risks. Academic Press. San Diego, CA.

Neff, J. 1990b. Effects of oil on marine mammal populations: model simulations, p. 35-54. In, Geraci, Joseph R. and David J. St. Aubin (eds). Sea Mammals and Oil: Confronting the Risks. Academic Press. San Diego, CA.

Nerini, M. 1984. A review of gray whale feeding ecology. pp. 423 - 450. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Nerini, M.K. and J.S. Oliver. 1983. Gray whales and the structure of the Bering Sea benthos. Oecologia (Berl.) 59(2-3):224-225.

Norris, K.S. and J.H. Prescott. 1961. Observations of Pacific cetaceans in Californian and Mexican waters. University of California publications in Zoology 63(11):291-402.

Oliver, J.S. and P.N. Slattery. 1985. Destruction and opportunity on the sea floor: effects of gray whale feeding. Ecology 66(6): 1965-1975.

Omura, H. 1974. Possible migration route of the gray whale on the coast of Japan. Sci. Rep. Whales Res. Inst. Tokyo 22:29-38.

Omura, H. 1984. History of gray whales in Japan, p. 57-77. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Omura, H. 1988. Distribution and migration of the western Pacific stock of the gray whale. Sci. Rep. Whales Res. Inst. (Tokyo). 39:1-9.

O'Shea, T.J. and R.L. Brownell. In press. Organochlorine and metal contaminants in baleen whales: A review and evaluation of conservation implications. Sci. Total Environ.

Perkins, P.and J. Barlow. 1992. Report on pinniped and cetacean mortality in California gillnet fisheries: 1990-1991. Southwest Fisheries Center, National Marine Fisheries Service. Administrative Report. LJ 92-14. 21p.

Pike, G.C. 1962. Migration and feeding of the gray whales (Eschrichtius robustus) Jour. Fish Res. Bd. Canada 19:815-838.

Poole, M.M. 1984. Migration corridors of gray whales along the central California coast, 1980-1982, p. 389-406. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Raftery, A.E., Givens, G.H. and J.E. Zeh. 1992. Inference from a deterministic population dynamics model about bowhead whale, Balaena mysticetus, replacement yield. Technical Report 232, Department of Statistics, University of Washington.

Reichert, W.L., B.-T. Le Eberhart, and U. Varanasi. 1985. Exposure of two species of deposit-feeding amphipods to sediment-associated [3H]benso[a]pyrene: update, metabolism and covalent binding to tissue macromolecules. Aquat. Toxicol. 6:45-56.

Reilly, S.B. 1981a. Gray whale population history: an age structured simulation. Document SC/33/PS8 presented to the Scientific Committee of the International Whaling Commission, June 1981.

Reilly, S.B. 1981b. Population assessment and population dynamics of the California gray whale, Eschrichtius robustus. PhD Thesis, Univ. of Washington, 279 p.

Reilly, S. B., Rice, D.W., and Wolman, A.A. 1983. Population assessment of the gray whale, Eschrictius robustus, from California shore censuses, 1967-1980. Fish Bull. 81(2):267-281.

Reilly, S.B. 1992. Population biology and status of eastern Pacific gray whales: recent developments. In, McCullough, D. and R. Barrett (eds). Wildlife 2001: Populations. Elsevier.

Rice, D.W. 1981. Status of the eastern Pacific (California) stock of the gray whale. In, Food and Agriculture Organization. 1981. Mammals in the Seas. Volume III. General Papers and Large Cetaceans. Food and Agriculture Organization. Rome. pp. 181 - 187.

Rice, D.W. and A.A. Wolman. 1971. The life history and ecology of the gray whale Eschrichtius robustus. Am. Soc. Mammal., Spe. Publ. 3, 1-142.

Rice, D.W., A.A. Wolman, D.E. Withrow, and L.A. Fleischer. 1981. Gray whales on the winter grounds in Baja California. Rep. Int. Whaling Comm. 31:477-493

Rice, D.W., A.A. Wolman and H.W. Braham. 1984. The gray whale, Eschrichtius robustus. Marine Fisheries Review 46(4):7-14.

Robisch, P.A. and Clark, R.C. 1993. Sample Preparation and Analyses of Trace Metals by Atomic Absorption Spectroscopy. In Sampling and Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992, Volume III, Comprehensive Descriptions of Elemental Analytical Methods. G.G. Lauenstein and A.Y. Cantillo, editors. NOAA Tech. Memo. NOS-ORCA-71, p. 111-150.

Rugh, D. 1984. Fall migration and census of the gray whale at Unimak Pass, Alaska, p. 225-247. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Rugh, D. and H.W. Braham. 1979. California gray whale (Eschrichtius robustus) fall migration through Unimak Pass, Alaska, 1977: a preliminary report. Rep. int. Whal. Comm. 29:315-320.

Rugh, D. and M.A. Fraker. 1981. Gray whale (Eschrichtius robustus) sightings in the eastern Bering Sea. Arctic 34:186-187.

Rugh, D., Breiwick, J., Dahlheim, M. and Boucher, G.C. In press. A comparison of independent, concurrent sighting records from a shore-based count of gray whales. Wildl. Soc. Bull.

Sloan, C.A., Adams, N.G., Pearce, R.W., Brown, D.W., and Chan, S-L. 1993. Northwest Fisheries Science Center Organic Analytical Procedures. In Sampling and Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992, Volume IV, Comprehensive Descriptions of Trace Organic Analytical Methods. G.G. Lauenstein and A.Y. Cantillo, editors. NOAA Tech. Memo. NOS-ORCA-71, p. 53-97.

Stinson, M. 1988. Baja Lagoon whale watching programs. p 10. In, Center for Marine Conservation/National Marine Fisheries Service. 1988. Proceedings of the Workshop to Review and Evaluate Whale Watching Programs and Management Needs. November 14-16, 1988. Monterey California.

Stoker, S.W. In press. Distribution and carrying capacity of gray whale food resources in the northern Bering and Chukchi Seas. In, Braham, H.W. and G.P. Donovan (eds), A Comprehensive Assessment of the Gray Whale. International Whaling Commission (Special Issue 14), Cambridge, U.K.

Sund, P. 1975. Evidence of feeding during migration and of an early birth of the California gray whale (Eschrichtius robustus). J. Mammal. 56(1):265-266.

Swartz, S.L. 1990. Comments on the carrying capacity of the gray whale breeding lagoons in Baja California and alternative breeding sites. Rept. int. Whal. Commn 40:162-163.

Swartz, S.L. and M.L. Jones. 1983. Gray whale (Eschrichtius robustus) calf production and mortality in the winter range. Rept. int. Whal. Commn 33:503 - 508.

Swartz, S.L., Jones, M.L. Goodyear, J., Withrow, D.E. and Miller, R.V. 1987. Radio-telemetric studies of gray whale migration along the California coast: a preliminary comparison of day and night migration rates. Report of the International Whaling Commission 37:295-299.

Tyack, P. 1988. Avoidance characteristics of bowhead whales and migrating gray whales, p. 14-15. In, Center for Marine Conservation and National Marine Fisheries Service. 1988. Proceedings of the Workshop to Review and Evaluate Whale Watching Programs and Management Needs. November 14 - 16, 1988, Monterey CA.

Varanasi, U., S-L. Chan, B.B. McCain, J.T. Landahl, M.H. Schiewe, R.C. Clark, Jr., D.W. Brown, M.S. Myers, M.M. Krahn, W.D. Gonlund, and W.D. MacLeod, Jr. 1989. National benthic surveillance project: Pacific coast, Part II, Technical presentation of the results for cycles I to III (1984-86). U.S. Dept. of Commer., NOAA Tech. Memo. NMFS F/NWC-170, 159 p.

Varanasi, U., Stein, J.E., Tilbury, K.L., Meador, J.P., Sloan, C.A., Brown, D.W., Calambokidis, J., and Chan, S-L. 1993. Chemical contaminants in gray whales (Eschrichtius robustus) stranded in Alaska, Washington, and California, U.S.A. U.S. Department of Commerce. NOAA Tech. Memo. NMFS-NWFSC-11, 114 p.

Votrogov, L. and L. Bogoslovskaya. 1986. A note on gray whales off Kamchatka, the Kuril Islands and Peter the Great Bay. Report of the International Whaling Commission 36: 281-282.

Vojkovich, M.M., R.J. Reed, and K.A. Hieb. 1987. Progress report: Southern California nearshore gill and trammel net study, 1986. Calif. Dept. Fish and Game. 55p.

Wang, P. 1984. Distribution of the gray whale (Eschrichtius robustus) off the coast of China. Acta Theriologica Sinca 4(1):21-26.

Wells, S.M. and J.G. Barzdo. 1991. International trade in marine species: is CITES a useful control mechanism. Coastal Mngt. 19:135-154.

Wild, P. A. 1985. Progress report: Central California gill and trammel net investigations (northern area), 1984. California Department of Fish and Game, Marine Resources Branch, Monterey, California 93940.

Wild, P. A. 1986. Progress report: Central California gill and trammel net investigations (northern area), 1985. California Department of Fish and Game, Marine Resources Branch, Monterey, California 93940.

Withrow, D., Hobbs, R., and Shelden, K. 1993. Offshore distribution of gray whales along the central California coast during the 1992-93 southbound migration. Unpubl. rept. submitted to Int. Whal. Commn (April 1993).

Yablokov, A.V. and L.S. Bogoslovskaya. 1984. A review of Russian research on the biology and commercial whaling of the gray whale. pp.465 - 485. In, Jones, M.L., S.L. Swartz and S. Leatherwood (eds). The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Zimmerman, S.T. 1989. A history of marine mammal stranding networks in Alaska with notes on the distribution of the most commonly stranded cetacean species, 1975-1987. Unpubl. Manusc., NMFS, Alaska Regional Office, Juneau AK 99802. 48 p.

APPENDIX A. IMPLEMENTATION SCHEDULE

1 Plan Development

a. Develop monitoring plan by 30 October 1993.
b. Secure funding for implementing plan by November 1993.
c. Develop research protocol for northbound "cow-calf" survey by November 1993.
d. Develop research protocol for southbound "peak-count"survey by November 1993.
e. Develop protocol for contaminant studies by November 1993.
f. Develop protocol for enforcement of whale watching regulations by January 1994.
g. Develop protocol for monitoring incidental mortality in fisheries in California, Oregon, Washington, and Alaska by December 1993.
h. Develop protocol for monitoring stranding events on the west coast and Alaska by November 1993.
i. Develop joint research proposal with government of Mexico regarding research and monitoring in the breeding lagoons at the next MEXUS-Pacifico meeting.

2. Implementation Schedule - no additional funds available

a. Initiate research on modeling by December 1993.
b. Initiate whale watching regulations by May 1994.
c. Initiate stranding monitoring protocol by December 1993.
d. Initiate monitoring fisheries mortality by December 1993.
e. Request information from Russian government on the magnitude of the subsistence harvest.

3. Implementation Schedule - approximately $100K in additional funds (in addition to those listed in Section II).

a. Initiate southbound survey 10 December 1993.
b. Incorporate information available subsequent to the 1990 assessment into the Bayesian synthesis assessment by May 1994.
c. Initiate northbound survey 15 March 1994.
d. Prepare report for IWC on 1993/1994 southbound survey and assessment based on Bayesian synthesis approach.
e. Based on analyses of northbound and southbound surveys, determine the optimal survey interval over next 5 years.

IV. Implementation Schedule - approximately $200K in additional funds (in addition to those listed in Sections II and III).

a. Continue collection of tissue samples from stranded animals.
b. Refine methodology for collection of biopsy samples by December 1993.
c. Collect initial biopsy samples during southbound migration to refine estimate of number of samples needed for quantitative assessment of mean contaminant concentrations for the population (January 1994).
d. Collect additional biopsy samples from southbound migration to provide quantitative estimate of mean contaminant concentrations for the population (February 1994).
e. Collect biopsy samples during northbound migration (April 1994) for determination of contaminant concentrations of cow/calf pairs.
f. Collect tissue samples from Russian subsistence harvest, beginning in July 1994, for comparison of contaminant concentrations between and within stocks of gray whales.

V. Implementation Schedule - approximately $400K in additional funds (in addition to those listed in Sections II, III, and IV).

a. Initiate study on the proportion of gray whale population that utilizes coastal sanctuary waters (i.e., Channel Islands National Marine Sanctuary for an estimated $30-50K) to determine importance of sanctuary relative to critical habitat and recovery.
b. Initiate joint research with Mexico along Baja California concerning usage of critical habitat, calf production, and survival.
c. Initiate research on frequency and size distribution of prey items on the summering feeding grounds for comparison with existing data relative to potential density dependent responses in prey availability.

APPENDIX B
OUTLINE OF INFORMATION NEEDS AND PRIORITIES FOR THE REST OF THE 5-YEAR MONITORING PERIOD

I. Information Needs.

A. Abundance, distribution, population trend, and status information.
B. Calf production and pregnancy rate information.
C. Habitat utilization.
D. Potential anthropogenic concerns (e.g., contaminants, entanglement in fishing gear, and whale watching).
E. Level of aboriginal harvest.

II. Priorities

A Highest Priority
1. Abundance and population trend data.
2. Calf production and pregnancy rate data

B. Medium Priority
1. Level of aboriginal harvest.
2. Bayesian synthesis.
3. Contaminant studies (i.e., toxic chemicals).

C Lower Priority
1. Habitat utilization (information on the need to further protect habitat critical to breeding and feeding).
2. Anthropogenic concerns other than contaminants.

APPENDIX C
LIST OF MEMBERS OF THE GRAY WHALE MONITORING TASK GROUP

Howard Braham (Chair)	ALASKA FISHERIES SCIENCE CENTER
Jeffrey Breiwick	ALASKA FISHERIES SCIENCE CENTER
Robert Brownell	SOUTHWEST FISHERIES SCIENCE CENTER
Marilyn Dahlheim	ALASKA FISHERIES SCIENCE CENTER
Douglas DeMaster (Vice-Chair)	ALASKA FISHERIES SCIENCE CENTER
Kenneth Hollingshead	OFFICE OF PROTECTED RESOURCES
Jeffrey Laake	ALASKA FISHERIES SCIENCE CENTER
Stephen Reilly	SOUTHWEST FISHERIES SCIENCE CENTER
John Stein	NORTHWEST FISHERIES SCIENCE CENTER
Steven Swartz	OFFICE OF THE CHIEF SCIENTIST
Grant Thompson	ALASKA FISHERIES SCIENCE CENTER

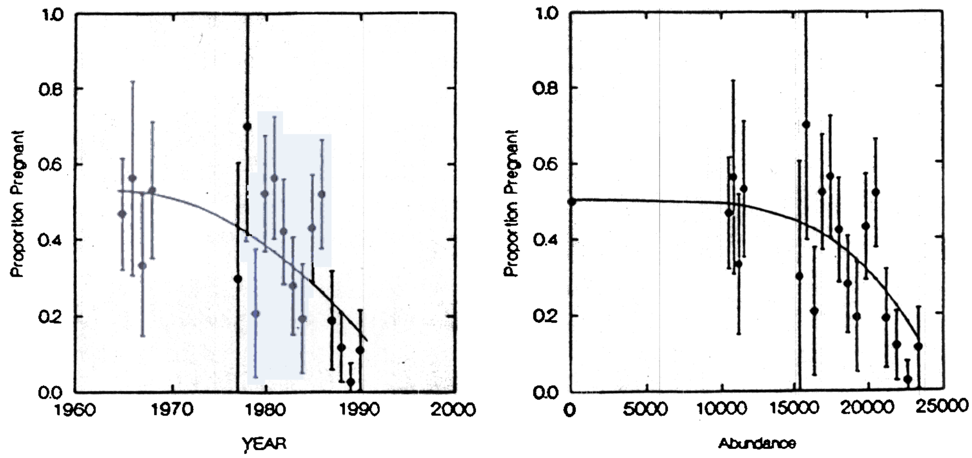

Fig. 1. a. Gray whale pregnancy rates, with binomial 95% confidence limits, by year, from the Soviet aboriginal fishery (Blokhin 1984, 1989, 1990, 1991, and Zimushko and Ivashin 1980). b. Gray whale pregnancy rates with 95% confidence limits by estimated population sizes. Pregnancy rates from Blokhin (1984, 1989, 1990, 1991), Breiwick et al. (1989), and Withrow (1990); abundance estimates from exponential increase model fit to Monterey census data from Breiwick et al. (1989). (from Reilly 1992)

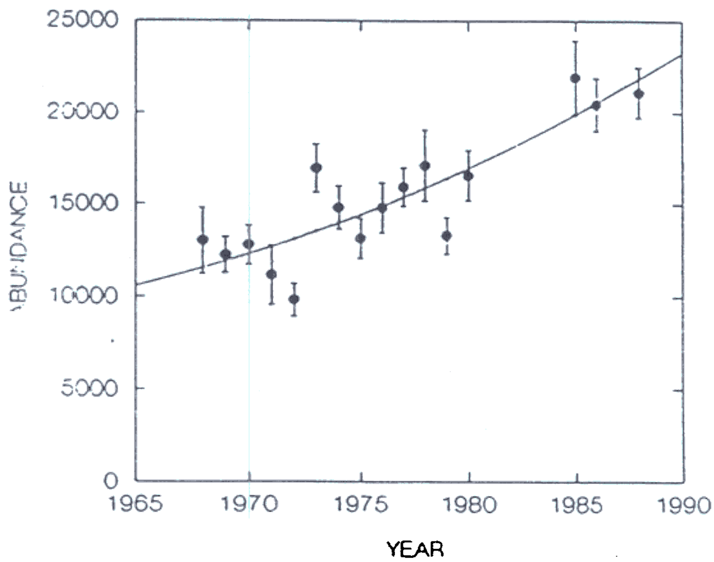

Fig. 2. Gray whale abundance estimates with 95% confidence intervals, by year, from Monterey shore censuses. Fitted line is from exponential regression weighted by reciprocals of squared standard errors (Buckland 1990). (from Reilly 1992)